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SURGICAL TREATMENT OF OCULAR DEVIATIONS AS AN IMPORTANT FACTOR IN ORTHOPTICS

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THE surgeon's share in dealing with ocular deviations is a twofold one. On the one hand, in *heterophoria,* by removing obstacles he makes it easier for the patient to use his two eyes together, thus relieving symptoms.

On the other hand, in *heterotropia,* by removing obstacles he makes the patient appear more normal—a great cosmetic advantage — and he may even make it possible for the patient to use his eyes together in binocular single vision.

The surgeon accomplishes this by operating on the oculorotary muscles in two ways: he changes the attachments of the muscles to the eyeball, moving them forward or backward, or he shortens or lengthens the muscles.

Why should there be any necessity for changing the muscles in these ways and what are the results? It is commonly taught that the need for these operations is fundamentally to strengthen some muscle that is too weak or to weaken a muscle that appears to be too strong. This mistaken point of view, like most errors, is misleading, although curiously enough it has appeared to work out in practice, as we shall see.

The most illuminating approach to the problem is that of Chavasse, who pointed out that at birth a child is almost blind. The eye and the other parts that are concerned with seeing, which constitute the organs of vision, are very incompletely developed. They need to grow anatomically before they can do effective seeing. This applies not only to the eyeball, the retina, the optic nerve, and the ciliary muscle, but equally well to the cerebral parts of the visual apparatus, the physiologic adjustments (reflexes) that must be acquired, and the visual memories that must be stored.

Chavasse further pointed out (and this is extremely important) that as the eyes and the visual functions develop, *various obstacles are encountered.* In the ordinary normal child, nature deals successfully with these obstacles and satisfactory binocular vision is achieved. In many children, however, these obstacles give rise to more or less serious defects of monocular or binocular vision or both. It is to these obstacles that attention is now directed. What are they, what are their consequences, and how are they to be handled?

Chavasse divided them into sensory and motor obstacles. They might be classified as anatomic and physiologic or functional. Probably in the last analysis, all are basically anatomic. We are especially interested in those obstacles which directly or indirectly affect the motor functions because it is these that may be dealt with by surgery. These motor functions are reflexes (in the order of their development): postural, fixation, refixation, vergence, fusion.

Among the most important anatomic motor obstacles are variations in the orbital structures: one eye higher than the other, eyes more widely separated than normal, structural variations in the oculorotary muscles and tendons and their connective tissue attachments, especially the capsule of Tenon and the check ligaments.

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Consider the profound changes that take place in the relations of the eyes and orbits in the process of development from the early fetal stage, when the orbital axes diverge 170 degrees, to the condition in the young child when the orbital axes still *diverge* 90 degrees but the visual axes have to *converge* for near vision, the ordinary status in which the child uses his eyes. His world is a near world and he has to be able to converge often as much as 90 degrees—45 degrees for each eye.

When one considers the growth and development of the bony orbits and of their contents (a mass of muscles, nerves, blood vessels, connective tissue, and fat), it is obvious that there are many possibilities for obstacles to smooth functioning. Many circumstances will arise that necessitate variation in the reflex adjustments. The importance of these adjusting mechanisms cannot be exaggerated. It is by these that nature overcomes the many obstacles that are bound to arise. Unless one has a vivid picture in his mind of these obstacles and of these adjusting mechanisms (reflexes), one cannot go far in comprehending or in successfully treating defects of binocular vision. The first principle of control by the adjusting mechanisms is the law that innervations always go to both eyes and to both equally. If, while the left eye is covered, the right eye fixates a point, the left eye under cover always moves with the right eye. This is obviously designed to favor binocular functioning. When it works ideally, the left eye moves so exactly with the right that on removal of the cover no correcting adjustment is needed. There is no movement of redress.

Thus one has, on the one hand, the picture of the anatomic and physiologic growth and development of the visual apparatus extending over a period of five or six years or more. This should culminate in normal visual acuity in each eye and normal binocular vision of the two eyes together. On the other hand, there is the picture of various obstacles to this normal development of the visual apparatus. How does nature meet these obstacles? What can the ophthalmologist do? What can the orthoptist do? What can the surgeon do?

First of all, what can nature do? During the first few months and years of life, nature completes the growth and development of the anatomic structures indispensable to the function of vision. Nature has also provided certain reflexes which perform automatically the adjustments required for normal seeing. These reflexes are (1) the fixation and the refixation reflexes for conjugate movements of fixation — versions; (2) the vergence reflex for changes of distance; and (3) the fusion reflex to correct imperfections in binocular adjustments. These reflexes are not fully developed and efficiently acting for some years after birth, at least five or six years. When they have reached their full, perfect, complete and sufficient development, binocular vision is normal and effortless. Only when this development is incomplete, imperfect, insufficient, or even abnormal is there anything left for the orthoptist or the surgeon to do.

Keep in mind this basic fact in the way nature meets the obstacles: there is a *powerful underlying urge toward binocular vision* which impels the child to try this way and that to overcome or to evade the obstacles that may arise, seeking to make the best of whatever anatomic and physiologic conditions he possesses. This underlying urge, together with the growth and development during the first five to ten years of life, is of extreme importance to the orthoptist and makes possible her almost miraculous success in dealing with certain obstacles to binocular vision. The reflexes are in process of formation and

are not yet fixed. They can be modified, redirected, improved, and altered by skillful handling by the technician who knows how they work and, therefore, how to aid nature.

What can the ophthalmologist do? It is peculiarly his job to discover and identify the obstacles which hinder the normal development of seeing. His first task is to find out what nature has done so far. This requires an ophthalmologic examination which should be fairly complete. What structural anatomic conditions exist? What defects are present? Are they of such a nature that anything can be done about them? What is the visual acuity and what refractive errors are present?

From the standpoint of binocular vision, the all-important investigation of the ophthalmologist concerns the deviations. It is because the two eyes do not work together that binocular vision is a failure. Therefore the ophthalmologist must give special attention to the deviations that are always present and, if large enough, may interfere with binocular vision. The magnitude of the deviation is a measure of the task of the fusion reflex whose function is to correct any deviation.

The next important measurement is determining the amplitude of fusion. The amplitude of the vergences (which is the amplitude of the fusion reflex) determines the ability of the fusion mechanism to deal with the deviation—its ability to perform its required task.

The task of the ophthalmologist in searching for obstacles leads him to measure the deviation which shows how far the eyes are from working together and which is the main obstacle to binocular vision; second, he searches for possible causes for the deviation. If he finds hypermetropia, it may account for an esodeviation. Often he finds no, or insufficient, cause. He cannot dissect the orbit nor explore with his microscope the intricate details of the neuromuscular mechanisms. (Recall that each oculorotary muscle has over ten thousand nerve cells in the nuclear centers and these have countless interconnections and also countless supranuclear connections.)

What he always finds is the deviation. It is because the eyes deviate that they either cannot work together or do so with difficulty.

Doubtless the most conspicuous cause of ocular deviation is paralysis of one or more muscles. This is not only conspicuous, it is so easy to understand that a deviation would result from paresis or paralysis that the tendency has been to attribute almost all deviations to weakness or relative weakness of some muscle or muscles or in some cases to overaction—too great strength or relatively too great strength. It is curious that so many writers and teachers have not had the penetration to see the difference between imperfect action due to defective mechanical orientation, to lack of skill, to awkward performance or to undeveloped coordination on the one hand, and to sheer weakness or lack of power on the other hand. There are so many striking illustrations of this fundamental difference! For example, the right eye can rotate upward, say, 45 degrees, and the left eye can rotate downward 50 degrees: sursumduction, 45 degrees; deorsumduction, 50 degrees. If both movements were made simultaneously, the vertical vergence would be 95 degrees. The strength of the muscles could easily accomplish this movement of vertical vergence. The reason the rotation is limited to 45 degrees upward and 50 degrees downward is not because that is all the muscles are strong enough to do. It is because the checking structures prevent greater rotations which, if they were permitted, might damage the numerous nerves, arteries, and veins that enter and leave the eyeball.

Actually the average normal person can execute a vertical vergence (one eye up, the other down at the same time) of about one degree.

Another example: Each eye can abduct 50 degrees. As far as the strength of the muscles is concerned, the amplitude of divergence could be 100 degrees if both eyes could abduct simultaneously to the maximum amount. Actually what is usually found is an amplitude of divergence at far of 3 to 4 degrees.

It is, of course, possible to have a weak or weakened muscle. It would show itself by impaired movement of the eye in the particular field of action of that muscle: abduction, if the muscle is a lateral rectus; adduction, if a medial rectus is weak. There would also be impaired convergence or divergence in such cases. One can not reverse the argument and say that if there is impaired convergence or divergence, it proves the weakness of a medial or lateral rectus muscle respectively.

A simpler way of looking at it is this: if the prism divergence is, let us say, 2 prism diopters but there is an eso-deviation of 10 prism diopters, then the effective divergence is 10 plus 2, or 12 prism diopters, not at all a sign of weakness. The trouble is much more easily understood if regarded as an eso-deviation, that is, defective mechanical orientation. What Duke-Elder calls a defective mechanical orientation shows itself in the examination of the patient as a deviation plus poor amplitudes. If the position of the eyes is corrected to less than 2 or 3 prism diopters instead of 10 prism diopters, or even to a slight exodeviation, then the divergence tested by prisms or by an amblyoscope would be over 10 prism diopters and the symptoms relieved not because the lateral rectus had been made stronger by resection or the medial rectus made weaker by recession or both but simply because the deviation had been corrected, the position of the eye in its socket changed, the mechanical orientation improved. The obstacle to easy binocular vision was not a weak lateral rectus or a too strong medial rectus but a *deviation* of the eyeball in its socket with reference to the position of its mate — a *defective mechanical orientation.* Unfortunately time will not permit applying the same line of reasoning to many other cases, as one is tempted to do.

If the key that fits most cases is the correction of the deviation, why is it that surgeons every day are curing cases by operations aimed at strengthening or weakening a muscle deemed guilty? It is simply because these operations *do* correct the deviations by improving the mechanical orientation even though this was not the guide and goal.

The same error of approach, the same misconception of the obstacle to be overcome, has led many orthoptists to try to strengthen some hypothetically weak muscle. It is the function or the reflex that is deficient and not the muscle that is weak. What is the difference? Think of the amplitude of vertical vergence.

In some cases the obstacle can be removed or reduced by surgery; often enough the deviation is not the whole story. Even after it has been corrected, some training of the functions may frequently be necessary.

Do not try to reduce all cases to a simple universal basis. The more one studies the problem of binocular vision, the more one finds new facets. Those who would reduce it all to a correction of the deviation or those who would reduce it all to a weak muscle or a too strong muscle have much to learn.

What can the orthoptist do? Some would include under orthoptics the whole field of disturbances of ocular motility. The competent orthoptic technician, they say, must be able to make a diagnosis of any defect of binocular vision in order to tell whether the case is

one that can be helped by orthoptics. To evaluate the merits of orthoptic treatment, the orthoptist must be able to weigh it against other types of treatment. She must be sufficiently versed in refraction to tell what is needed in this field—what there is that may have a bearing on binocular vision. Obviously, fairly good visual acuity in each eye is a prerequisite to binocular single vision and necessitates adequate treatment of refractive errors.

If there are anatomic pathologic defects that make binocular vision impossible, the orthoptist will be wasting her time and the patient's time and money, as well as earning a bad reputation for orthoptics, if she does not diagnose this obstacle promptly and reject the case for orthoptic treatment until the pathologic obstacle has been eliminated by the ophthalmologist.

Many of the obstacles to ocular movements—obstacles to movements of fixation and to movements of fusion—have their seat in the central nervous system. In some cases there is a paralysis of one or more of the oculorotary muscles, but often there is no lesion of the nuclei or peripheral nerves or muscles; instead, the seat of the obstacle to binocular vision may be supranuclear. That the orthoptist should be competent to diagnose these defects and obstacles is held by some to be essential to the satisfactory practice of orthoptics.

Others take a different view. They say that it is the function of the ophthalmologist to make the preliminary study of the case and to refer the patient to the orthoptist *after* he has secured as perfect a pair of eyes as he can. The diagnosis of all pathologic defects and obstacles to binocular vision is definitely his field, and so is their treatment by nonorthoptic and even by some orthoptic means.

The two most important lines of treatment by the ophthalmologist are the correction of errors of refraction by glasses and dealing with various obstacles to binocular vision by surgery.

If there is amblyopia, it is certainly not the function of the orthoptist to tell whether it is due to a present or past retinal hemorrhage, to scars of the cornea or opacities of the lens or of the vitreous, or whether it is just due to suppression. It is for the ophthalmologist to advise treatment by occlusion and for him to observe the results of occlusion, though he may enlist the services of the technician in carrying out the details of occlusion.

These are the two extreme points of view. My own feeling is that the line separating the field of orthoptics and its allied and adjoining fields is not a sharply defined line and to attempt to build a wall upon the line is a mistake. The fact is that if you investigate, you will find that in different cities and in different offices and clinics the boundaries will differ. I have no quarrel with those who wish to extend the sphere of orthoptics. My quarrel is with those who would substitute for orthoptics those allied lines of work *leaving out the essential features which alone justify the existence of the specialty of orthoptics.*

If you leave out the part of Hamlet himself in presenting the play of that name, it will not suffice to introduce instead Julius Caesar or Romeo or Shylock, fine as these are in their own setting. I have been forced to the sad conclusion that in many orthoptic clinics, orthoptics has been omitted.

The ideal to be set up, the goal which it should be the ambition of every orthoptist to achieve, is an alliance with one or a group of ophthalmologists where each fulfills his part, and where cooperation is constant and complete.

I do not see how the surgical treatment of patients who have had orthoptics can be carried out satisfactorily without cooperation.

There are cases where the experienced ophthalmologist perceives that certain obstacles to binocular vision must first be remedied before the patient can be successfully taught to give up his bad ways of seeing and learn new and better ways. There are other cases where he is not so sure and prefers to have the case studied by the orthoptist, who will report (1) whether the time for orthoptics is now, later, or perhaps already too late, (2) whether the obstacles to fusion could be so greatly reduced by surgical treatment that orthoptic treatment would be enormously facilitated, and (3) whether the risk of surgical interference is too great unless abnormal retinal correspondence can first be disrupted, as is sometimes, though rarely, the case. That the technician should advise what surgical operation should be done and on what muscle seems to me a gross shifting of the functions and responsibilities of the cooperating parties.

Having pointed out the ideal relations which should exist where ophthalmologist and orthoptic technician meet and frankly and fully discuss and jointly arrive at the best lines of treatment for each patient, I now hasten to admit that, realistically, the relations which do actually exist are in many cases different. There are situations where the technician has so much superior knowledge that she becomes naturally the one who makes the diagnosis and advises the surgeon what to do. In some cases she may be the actual assistant in the operations, and by long experience and natural aptitude she could very likely perform the operation and carry out the aftertreatment herself. I have no quarrel with such an arrangement except that it is not the ideal goal to be sought by the rank and file, but is the exceptional circumstance. Fortunate and happy the ophthalmologist who has such a treasure!

Particular emphasis should be placed on the special task (and prerogative) of the technician — *the making of the orthoptic diagnosis.* This is determining how the patient is actually using his eyes, what nature has so far accomplished (with or without the aid of the ophthalmologist), that is, at what stage the patient has arrived in his efforts to learn to use his eyes. This carries the corollaries: what is the next step, and what are the prospects? At this point the technician must appraise the patient's character, temperament, intelligence, docility, and especially his "readiness."

We have seen that nature has provided a mechanism for dealing with obstacles to binocular vision. The orbital architecture may be such as to cause a considerable deviation of the visual axes when one eye is covered to eliminate the correcting adjustments and to show the underlying deviation of the visual axes —the static zero position, the fusion-free position, or as some would have it, the "position of rest." Then, when the cover is removed and the automatic adjustments are permitted, it is found that this adjusting mechanism can take care of a large deviation, often very large, especially if, for example, it has developed gradually by the slow growth of an orbital tumor.

It is precisely this underlying urge to achieve binocular vision and to overcome by virtue of its adjusting mechanisms whatever obstacles to binocular vision may exist that makes orthoptics possible. The technician takes advantage of this normal urge and by her skillful direction and supervision guides the patient along the pathway. Her superior knowledge of how the eyes work and of how they ought to work and can work enables her to facilitate the process of *learning to see the best way.* It is because at certain periods the eyes and brain are acquiring their conditioned reflexes and the patient is learning to see the best he can with such eyes as he has that the

timing factor is so important.

I have gone far afield before taking up in detail the subject of the surgical treatment of ocular deviations. My purpose was to emphasize the predominant role played by the various obstacles to binocular vision which have to be overcome either by nature, by the ophthalmologist, by the orthoptist, or by the surgeon. The point of view I wish to establish is that the operative treatment of deviations attacks the obstacles, and in particular those obstacles which are not better dealt with by nature, by the ophthalmologist, or by the orthoptic technician.

These obstacles are (1) a deviation (phoria or tropia), large or small, which is giving trouble and is not successfully controlled by glasses correcting refractive error and prisms correcting deviations (especially vertical deviations but also horizontal if not too large), and (2) a deviation often associated with poor amplitude — either too small or poorly distributed (not properly apportioned between exodeviation and esodeviation).

The deviation is itself an obstacle and an exceedingly important one, but it may also be a manifestation or consequence of some other obstacle, especially of some anatomic obstacle. I wish to emphasize particularly, however, that a deviation may be a manifestation of a physiologic and not an anatomic obstacle and yet be favorably influenced by operation. It is obvious that correction of the deviation by surgery eliminates the symptoms whether the obstacle causing the deviation was anatomic in the orbit or whether it was physiologic. Thus, a patient with an accommodative convergent strabismus can not use his eyes together unless the deviation is removed; then if other conditions are favorable, it may be possible for him to learn to use his eyes together. At any rate he has a cosmetic cure. It is possible to remove the deviation by surgery, but if the cause of the deviation was hypermetropia, the proper treatment was to remove this cause, thus removing the obstacle without surgery but with suitable glasses. In either case the removal of the deviation was the removal of the obstacle, in one case by glasses and in the other by surgery.

Cases in which deviation is reduced but not abolished by glasses are fairly common. These have an active accommodative factor, but because there are other factors, the glasses give only partial reduction of the deviation and a supplementary operation may greatly facilitate the work of the orthoptic technician. The reason is simply that it makes the job of the adjusting mechanism easier. There is less of an obstacle to be overcome.

Suppose one has had a case of paresis of an oculorotary muscle which has recovered. There is still a relative weakness of the old paretic muscle, but it is capable of rotating the eye as far as its check ligaments permit (good ductions) by the exertion of more than normal effort. This exertion results in the secondary deviation exceeding the primary deviation. A rather large deviation has resulted. It can be overcome by extra effort. If the deviation is removed by operation, the task of binocular vision is greatly reduced—a considerable obstacle has been removed.

"But," you say, "what you have done is to strengthen the weak (recently paretic) muscle." This I stoutly deny. The muscle is no stronger than before. What I have done is to reduce the obstacle by correcting the deviation so that *the task of the neuromuscular mechanism is greatly reduced; the strength of the muscle is not increased.* The muscles were strong enough before the operation to rotate the eye to the limit. They are no stronger now but their task is greatly reduced. The obstacle of the

deviation has been removed, the mechanical orientation improved. I have not added one more fiber to the muscle nor increased the size of the fibers already there, nor has the number of stimuli going to the muscles per second been increased or decreased.

Vertical deviations give some ophthalmologists more trouble than is necessary. If the deviation is 0.5 prism diopter or less, it can usually be dealt with by nature's method of fusion but may in some cases need orthoptics to increase the vertical amplitudes.

If the vertical deviation is between 1 and 4 prism diopters, it can rarely be dealt with by fusion without help and then only if a long and arduous period of training is devoted to increasing the vertical amplitudes. It is so much easier to relieve these patients with prisms that one seldom subjects them to prolonged orthoptics. The deviation can be promptly eliminated by prisms base up or down.

If the vertical deviation is greater than 4 prism diopters—hyperphoria or hypertropia — it is easily corrected by operation on the inferior rectus muscles, which are the easiest and safest to work on of the vertically acting muscles. Increasing the action by shortening rather than reducing the action in the other eye by lengthening is to be preferred since the eyes do so much of their seeing in the lower part of the visual fields—reading, working, walking.

If the vertical deviation is more than 12 prism diopters, no brief cut-and-dried directions can be given. Each case must be studied and decision based on the findings.

It is the large number of small hyperphorias and hypertropias that are so easily managed by the three methods of treatment here grouped: amplitude training, prisms, and operation. Perhaps the most important single guiding principle is this: It is the deviation of such a character (direction and magnitude) that its reduction by operation would greatly facilitate and shorten the necessary orthoptic treatment? If so, operation should be urged.

Another important principle is the "step-by-step" procedure advocated by Duane, Chavasse, and Duke-Elder, three of the many who advise it. This means that the deviation is first reduced in part and this gain consolidated before a second, and often a third, operation is done, gradually reaching the goal and apportioning the surgery among the different muscles to the best advantage.

The final point I wish to discuss is the timing of the operation. I shall advocate early operation and repeated operation.

Operations on a deviation are performed for one of two reasons. Either they remove obstacles so that binocular vision is possible or they are for cosmetic purposes. If an operation is done to facilitate binocular vision, it is obvious that if the obstacle to binocular vision is in some way removed before the normal developmental period has passed and even before nature has begun the abnormal adjustments of suppression and deviation by which she deals with such obstacles, the prognosis is far better than if the removal of the obstacles by operation is postponed until the abnormal reflexes, the perverted visual habits, have become established. Then nature's period of cooperation is passed, and the only way binocular vision can be secured is by undoing the work nature has done in dealing with the obstacles by establishing a deviation with suppression. This means overcoming the suppression, learning to see double and then learning to avoid diplopia by fusion instead of by suppression, a program which is usually hopeless without a competent and skilled technician.

If the patient comes from not too great a distance, some *preliminary treatment* is highly desirable. There are sev-

eral things one would like to know before operating:

1. How significant is the hypermetropia?
2. What effect will correcting lenses have?
3. What is happening to visual acuity—amblyopia?
4. Is there a fundus lesion affecting visual acuity?

Questions 1 and 4 can be answered by atropinization, retinoscopy, and ophthalmoscopy. Point 2 can be answered by trial in a few weeks. Number 3 can be estimated, and in particular one can determine whether the patient prefers one eye consistently over the other. If so, then occlusion is indicated. In the young child occlusion results in a rapid improvement in the absence of retinal and other defects.

The delay necessitated by these studies is entirely permissible and, in fact, to be recommended, because during the occlusion the patient will not be developing objectionable reflexes. The improvement in the eye resulting from occlusion of the fellow eye and constant foveal stimulation is ample excuse for the delay.

Are there any other cogent arguments in favor of postponing the operation? One frequently hears of the risk of general anesthesia in a young child. With an expert anesthetist, this is negligible. Some say that the operation is more difficult in the very young child. To the competent surgeon, such an argument is nonexistent. The operation is not difficult, and moreover, the same operation will produce a greater effect at this age. Furthermore, the exactness of effect is less necessary than in older patients because at this early age nature is lending a hand to cooperate; in some of the older cases nature is antagonistic in trying to preserve the status quo, which is so satisfactory to the patient since he has learned to see well and to see comfortably and easily in his abnormal way.

Of course it is better for the development of the child's personality not to have him influenced in the direction of an inferiority complex during the formative years.

In review, the arguments are overwhelming in favor of very early operation—not later than the age of two years—if one wishes to try for binocular vision.

If one has a skilled technician and can depend upon her to undo the faulty habits (reflexes) the child may have acquired by postponing surgery, he may use that as an argument against early operation to bolster the well-known fact that most surgeons have not yet learned the value of early surgery.

If only a cosmetic cure is sought, the operation can be done at any time. If one waits even until six or eight years, many cases can be done under local anesthesia. There are many good surgeons, however, who believe a general anesthetic is better even in patients who are old enough for a local. If one stretches a point and tries local anesthesia in a borderline youngster who proves a bad actor, the operation suffers because the surgeon is hampered by the bad acting and tries to finish as quickly as possible even if it means sacrificing some details. In such cases the memory of the operation may cause the patient to object to a second operation when it is indicated later.

As already mentioned, eminent authorities advocate planning in the beginning to do a second operation if it is indicated. If this is not made clear to the family at the beginning, it may cause bad feeling if it is suddenly presented to them later. If all is clearly explained in the beginning, there will be no misunderstanding and no consequent bad feeling.

In the comparatively rare cases of weakness of some muscle, one naturally attempts to favor the action of this mus-

cle, since he cannot strengthen it. This can be accomplished in part by improving the mechanical orientation of the muscle, but more significantly, by reducing the task of that muscle by reducing the deviation. One also attempts to encourage the development of the normal basic reflexes (fixation, refixation, fusion, even postural) by removing obstacles.

Since we should not, in the interest of clear thinking and understanding of the subject, lay stress upon weak muscles, what should we substitute? The answer is: Substitute weak *functions*—versions and vergences. The vast difference between a weak muscle and a weak function appears in the prodigious contrast between the vertical ductions which show the ability of the elevators and depressors to move the eyes (often thought of as strength of the muscles) and the ability of these same elevators and depressors to produce vertical vergence. They are strong enough to rotate an eye up 45 degrees and down 50 degrees. Why are they so apparently weak in vertical vergence? Obviously not because any muscle is weak, but equally obviously because a certain function is weak. This function is the fusion of vertically separated images of the same object.

The function or reflex of fusion of horizontally displaced images in convergence or divergence acts on the same principle. The reflex of divergence is developed three times more than vertical vergence because it is more frequently needed in the interest of binocular vision. The reflex function of convergence is vastly more in demand than the other vergences and even has some voluntary features. Convergence is ten times as large as vertical vergence and three to ten times as large as divergence. Moreover, these vergences are capable of development and increase by exercises in somewhat the same ratio. Convergence is far easier to increase in amplitude than divergence and vastly more easy to increase than vertical vergence.

I submit, therefore, that we should cease to emphasize — almost cease to mention—the weak muscle and think instead of weak or poor amplitudes of vergence, poor reflex development, and poor mechanical orientation.

Since deviations may be of two kinds, (1) anatomic or mechanical and (2) innervational or functional, there is a widespread but mistaken conviction that the corollary to these fundamental facts is that orthoptics is useless in the mechanical type which always requires surgery, and that surgery is contraindicated in the functional type. The truth is that surgery is often useful in the functional type and orthoptics is often useful in the mechanical type.

Another rather widespread error is the belief that prolonged occlusion shows the true deviation and is the best guide to surgical "dosage." This is based on the fact that compensation hour after hour and day after day leads to a "spasm," that is, an excessive tonus which is relaxed by prolonged occlusion. As a matter of fact, there are always many hours a day during which the eyes are not fusing and in which, therefore, the excessive tonus is relaxed even without occlusion. Moreover, conditions are so altered by prolonged occlusion that the resulting deviation is not the true position resulting from the elimination of fusion, but other factors are also eliminated and new innervational factors introduced, especially the very basic tendency for a covered eye to rotate upward. Therefore, do not base surgery on the findings of prolonged occlusion unless confirmed by other evidence; especially, always cover the opposite eye for a prolonged period and compare the result of prolonged occlusion on each eye. The fallacy of the method will usually be revealed when this is done.

I have selected certain aspects of the surgical treatment of ocular deviations for emphasis.

1. The purpose of surgery is to eliminate obstacles to binocular vision and to favor normal binocular functioning.

2. Whatever their basic fundamental nature or wherever situated, these obstacles show themselves as deviations—motor obstacles. Just as surely as any obstacle amounts to anything, it will show itself by a deviation.

3. If there is a weakening of some muscle, it surely shows itself as a deviation. If the weakness is not a complete paralysis but only paresis, then correcting the deviation places the eyeball in a position from which even the weakened muscle can produce the adjustments which are necessary for binocular vision and which it can not make when the deviation exists because the deviation adds just so much to the task of the weak muscle.

4. In addition to correcting (removing) the deviation by improving the mechanical orientation, the operation attempts to increase the amplitudes and especially to produce an apportionment of the amplitudes on either side of zero; it attempts indirectly to favor the development of normal reflexes since the underlying urge toward normal binocular vision quickly takes advantage of the more favorable conditions after the obstacles are removed, especially if it is done before visual perversions have been acquired or become fixed—deviations, suppression, anomalous correspondence.

DISCUSSIONS

MISS RUTH FISHER, Denver, Colo.: For a number of years orthoptic technicians have looked to Dr. Lancaster for approval and guidance, and so it is a real pleasure to hear him tonight. It seems logical from my point of view to reverse the title of this paper and to discuss orthoptics as an important factor in the surgical treatment of ocular deviations. At least it places me in a more favorable position. It is important to treat the patient preoperatively as well as postoperatively. The chief sensory obstacles which may be encountered and eradicated are amblyopia, suppression, and anomalous retinal correspondence. The goal is the institution of equal visual acuity, alternation, and ideally, binocular single vision.

The orthoptist aids in the removal of one or all of the above factors and in addition should have in readiness for the surgeon a cooperative and what I choose to call an "examinable" patient. To establish this state of affairs takes some knowledge of child psychology, but mostly it takes patience. A varying number of visits, depending on the nature and adaptability of the individual child, will be required. No set number of treatments need be determined in advance, but a mutually cooperative program must be arranged with the parents both for office and home training.

Dr. Lancaster has said, "The ideal set-up, the goal which it should be the ambition of every technician to achieve, is an alliance with one or a group of ophthalmologists where each fulfills his part, and where cooperation is constant and complete." Happily, this is the only set-up under which I have ever worked. The ophthalmologist is available personally to analyze each factor and the need for continued treatment.

Under such an arrangement there can be no misinterpretation of findings between ophthalmologist and technician. With this kind of cooperation, valuable data are accumulating as we correlate and catalog our findings. Now, with further orthoptic training and observations, an individual plan is outlined and followed for each patient Those cases which are amenable strictly to orthoptics are given orthoptics and those which require surgery get that.

Immediately following their dismissal from the hospital, these patients return to the office for re-evaluation and, particularly, for an estimate of the results of surgery. This is always under the scrutiny of an ophthalmologist. Also upon me at this point falls the responsibility of demonstrating the extent of fusion.

It is the opinion of Dr. O'Rourke, Dr. Starr, and myself that, as an *aid* to diagnosis and

treatment, orthoptics is invaluable in the surgical treatment of ocular deviations.

MRS. LUCIA NUGENT, Los Angeles, Calif.: Dr. Lancaster has said that he feels a difference of opinion makes a discussion more worth while. This proves a little awkward in my case, for I find it very difficult to disagree with Dr. Lancaster's statements.

I am sure that we are all agreed that the relationship between the ophthalmologist and the orthoptic technician should be as Dr. Lancaster recommends. The technician to be of use in her field must have training which enables her to interpret her own findings and those of the ophthalmologist, but *never* had it been intended that she act as a diagnostician.

In my opinion, the removal of the various obstacles to binocular vision is a problem to be handled jointly by the ophthalmologist and the orthoptic technician, and should not be approached with a surgery versus orthoptics attitude.

With the exception of the purely accommodative squints, the manifest deviations require surgery to put the visual axes in a position approximating parallelism. Orthoptic training may teach the patient to overcome a small postoperative angle, and such training is of significant value in the treatment of amblyopia, suppression, and anomalous correspondence, but seldom, if ever, does orthoptics alone change the angle of squint appreciably.

The purely accommodative squints are controlled with plus lenses and orthoptic training, but there is a large group which has a residual angle after the accommodative factor has been corrected, and these cases require surgery to remove that part of the deviation not corrected by plus lenses and orthoptic training. Thus, even in this group which, aside from refraction, is sometimes considered to be an orthoptic problem, surgery and orthoptics work as a team.

In the case of the periodic tropias, the patient may have been taught to overcome his deviation and to maintain fusion by the use of orthoptics, but in many cases he will do so with less ocular fatigue if helped by surgery.

The same applies to the phorias. Many of these patients are given comfort by orthoptic training alone, but there are also those which require surgery to become symptom free.

Surgery, orthoptic training and the use of lenses make a closely knit team.

The surgeon would be greatly handicapped without the use of orthoptics, and the orthoptic technician would be helpless without the surgeon.

I wish to thank Dr. Lancaster for his very informative presentation and for the privilege of discussing it.

ORTHOPTIC EVALUATION OF HYPERPHORIA

ELIZABETH A. BENNET*
DOROTHY A. THOMPSON**
ST. LOUIS, MO.

THE object of this paper is to report a preliminary study of an aid in the nonsurgical treatment of hyperphoria. Orthoptists are well aware of the frequent difference between objective and subjective vertical measurements on the major amblyoscope in the patient with hyperphoria when retinal correspondence is normal. We noted that often there was an increase in horizontal fusional amplitude with targets set at the subjective vertical measurement, as compared with the horizontal amplitude measured at other vertical settings. It was to evaluate this finding that the study was originally begun.

The nonsurgical treatment of hyperphoria is still far from satisfactory and consists of either prisms or orthoptics. Vertical prisms are particularly undesirable in cases where there is a large deviation because they are heavy and cause distortion. It is believed that 10 diopters of prism is the maximum that can be worn comfortably by the average patient. Also, if the deviation varies in amount when moving the eyes from right to left, prisms are obviously unsatisfactory. The rule to correct two-thirds of the deviation is purely empirical and must be disregarded in the consideration of many individual cases. White[4] believed that 98 per cent of all cases of hyperphoria were a result of paresis of one or more of the vertically acting muscles. The treatment of hyperphoria of small amount is often satisfactory with the use of vertical prisms. Scobee's scheme[1] for the prescription of vertical prisms utilizes a determination of (1) the fixing eye, (2) whether the hyperphoria is due to paresis of an elevator or of a depressor, and (3) whether the hyperphoria is greater at far or at near.

Scobee and Bennet's work[2] implies disagreement with White's figures on the frequency of paresis in the etiology of hyperphoria. They believe that many cases of clinically significant hyperphoria may have an innervational rather than a paretic origin.

Orthoptic training is completely satisfactory in but relatively few cases. The hyperphoria is seldom, if ever, changed in amount following orthoptics. Symptoms may be relieved temporarily by increasing positive fusional amplitudes.

It would appear that cases of hyperphoria which do not vary significantly in dextroversion, in levoversion, and in the primary position and are less than 10 prism diopters in amount would be ideal for the prescription of vertical prisms.

Unfortunately, some cases that fit in the above category will not be completely comfortable and in some others the hyperphoria will appear to increase with the passage of time. In the former instance the trial and error method may be used to determine the exact amount of prism with which the patient is comfortable, but often this is time consuming and inefficient. In the latter instance

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This study was done under contract with the Office of Naval Research as Project N6onr-202, Task Order I, NR 141-022.
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it has been found that only 18 per cent of cases with clinically significant hyperphoria show an actual increase in manifest hyperphoria after prescription of vertical prisms for constant wear.[2] These are the problems that interested us in the study of hyperphoria.

It is a recognized fact that hyperphoria may often be responsible for a lateral phoria, and less frequently, lateral phoria may produce hyperphoria, but the reasons have not been entirely clear. Based upon van der Hoeve's analysis[3] of Marquez' diagram, it is known that any movement of the eye requires innervations to all six of the oculorotary muscles. Obviously then, vertical movements properly performed require lateral muscles as well as vertical ones, and this would appear to be the origin of the relationship between lateral and vertical phorias previously mentioned.

Even in so simple a movement as abduction, more is involved than contraction of the lateral rectus and relaxation of the medial rectus. Since the obliques are also abductors from the primary position, they also receive a stimulus to contract at the same time as the lateral rectus. As the eye leaves the primary position, it enters a field of action of the obliques in which torsional movements may occur if the obliques are not equally innervated to counterbalance each other. Similar innervations must be sent to the vertical recti in order to maintain a proper horizontal alignment during abduction. If this balance is disturbed by a paresis of any of the vertically acting muscles, then a vertical deviation becomes apparent. In some instances this defect, if not too severe, will be overcome by fusion, and therefore a new balance must have been created and the innervations to *both* horizontally and vertically acting muscles must now be changed and maintained if fusion is to be comfortable and efficient.

If we assume that the foregoing explanation is true, it would seem that the horizontal rectus muscles must receive abnormal stimuli in the patient with hyperphoria in order to maintain fusion. When a vertical deviation exists as a hyperphoria, the amount of hyperphoria corrected by fusion will depend partly upon lateral innervations. When the patient with hyperphoria is examined on a major amblyoscope, the amount of vertical deviation measured by the orthoptist objectively (by flashing, equivalent to the cover test) frequently differs from that which the patient "wants" (subjectively) in order to make the targets appear level. From this, then, we reached the conclusion that a study of horizontal fusional amplitudes might give us some valuable clues about vertical deviations corrected by fusion.

A series of 20 patients has been studied for this preliminary report. Horizontal fusional amplitudes were determined both at near and far at a number of different vertical settings for the hyperphoric patient. If, for instance, the deviation objectively measured 5 prism diopters of right hyperphoria but the patient stated that the targets appeared level with 3 diopters of prism base down before the right eye, the fusional amplitudes were measured at that level and then as the vertical setting was changed (in steps of 1 diopter) from 0 to 10 diopters base down, assuming that the patient could maintain fusion over that range. In a large majority of cases, that level at which the lateral or horizontal amplitude (convergence and divergence) was greatest was also the vertical setting that the patient "wanted." Vertical prisms were then prescribed in the amount so indicated (3 diopters in this case). Results were surprisingly satisfactory.

Presumably the patient with hyperphoria has some particular vertical level at which lateral innervations can be most efficiently made to help compensate for

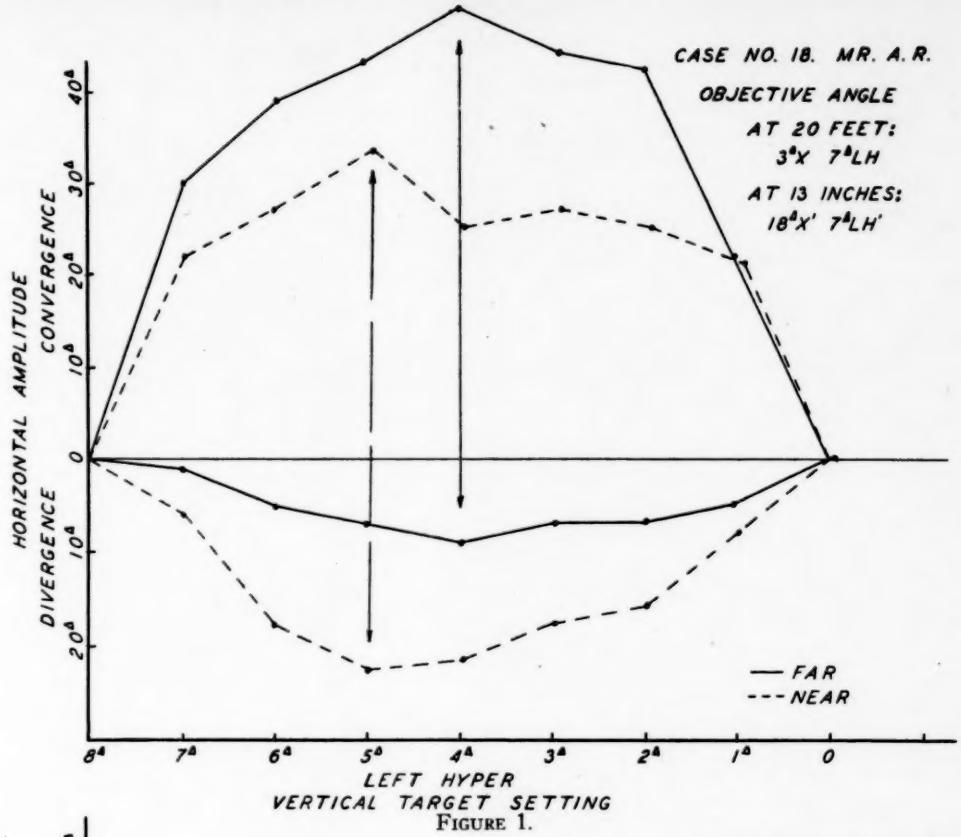

FIGURE 1.

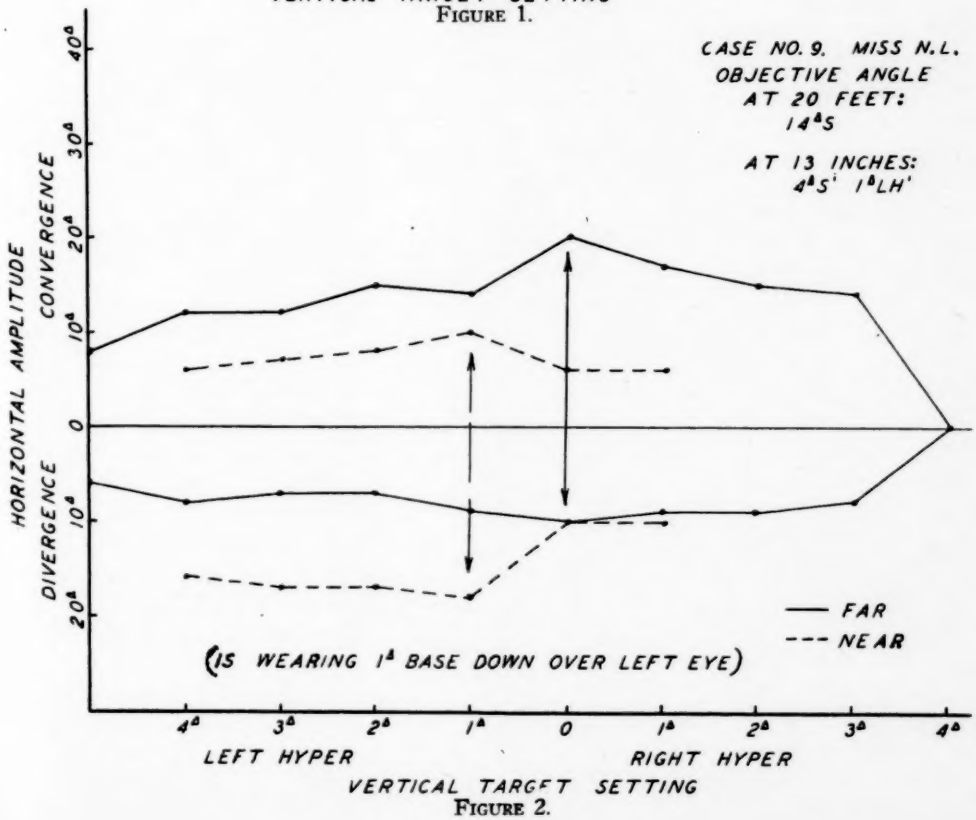

FIGURE 2.

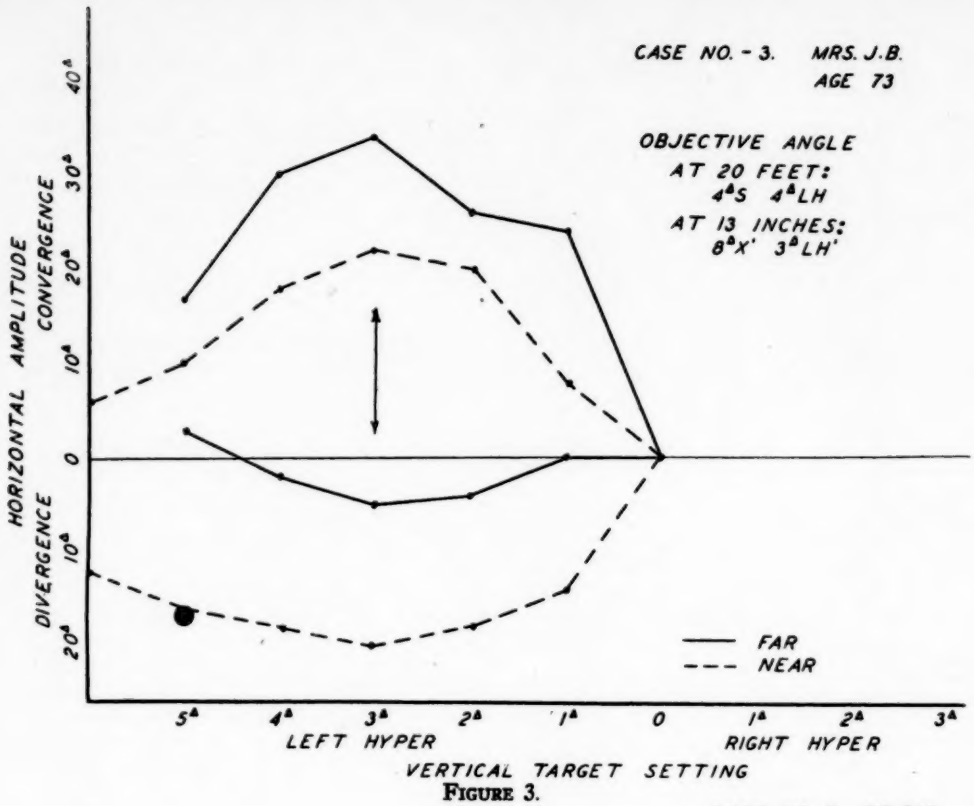

FIGURE 3.

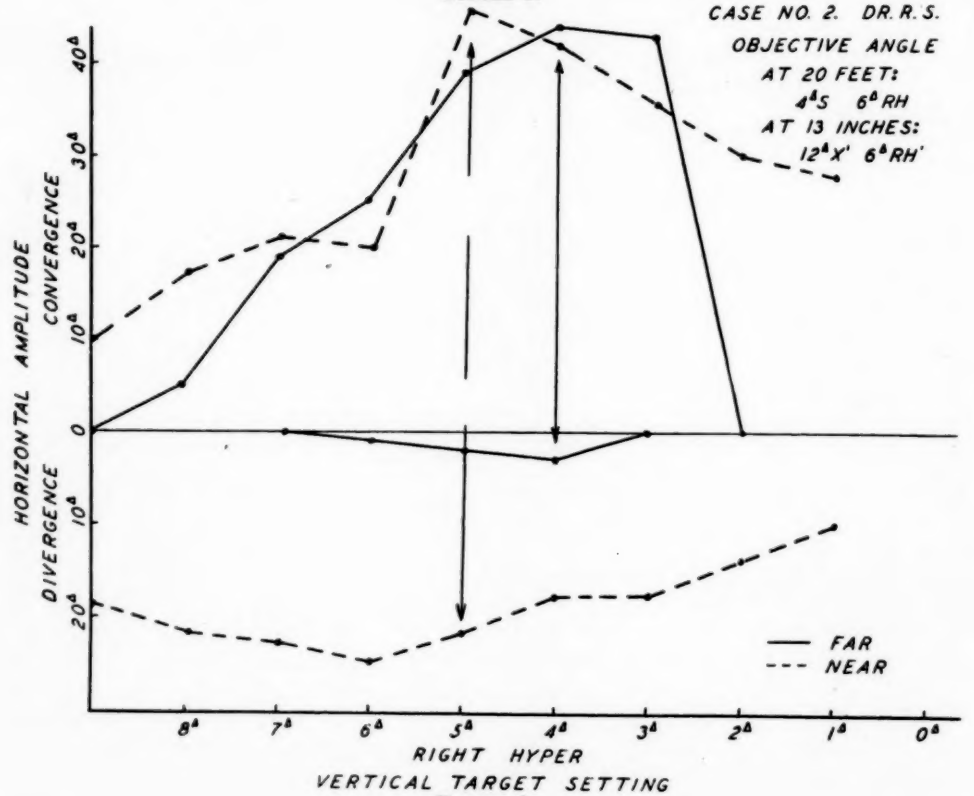

FIGURE 4.

the defect. This particular level is probably that at which the range of horizontal fusion is greatest. The results in actual cases seem to bear this out.

Manifest hyperphoria is that amount measured objectively with the two eyes dissociated. *Functional* hyperphoria is that amount measured subjectively when fusion is in force. It is apparently the amount of functional rather than manifest hyperphoria that it is important to know in order to prescribe vertical prisms which will bring comfort.

It is entirely possible that at least one cause of the apparent difference between objective and subjective hyperphoria, when present, is a result of vertical fixation disparity. We hope to study this possibility and report on it at a later date.

While measurements of far hyperphoria seem clinically reliable on the Troposcope, we should like to emphasize that near ones are of dubious reliability because it is not possible to measure the hyperphoria with the eyes in the true reading position on this instrument.

Patients for this study came either from the Washington University Motility Clinic or from the private practice of Dr. Richard G. Scobee and all patients were under his supervision. Data for the 20 cases are appended. For purposes of illustration, 5 cases are presented in graphic form (figs. 1-5).

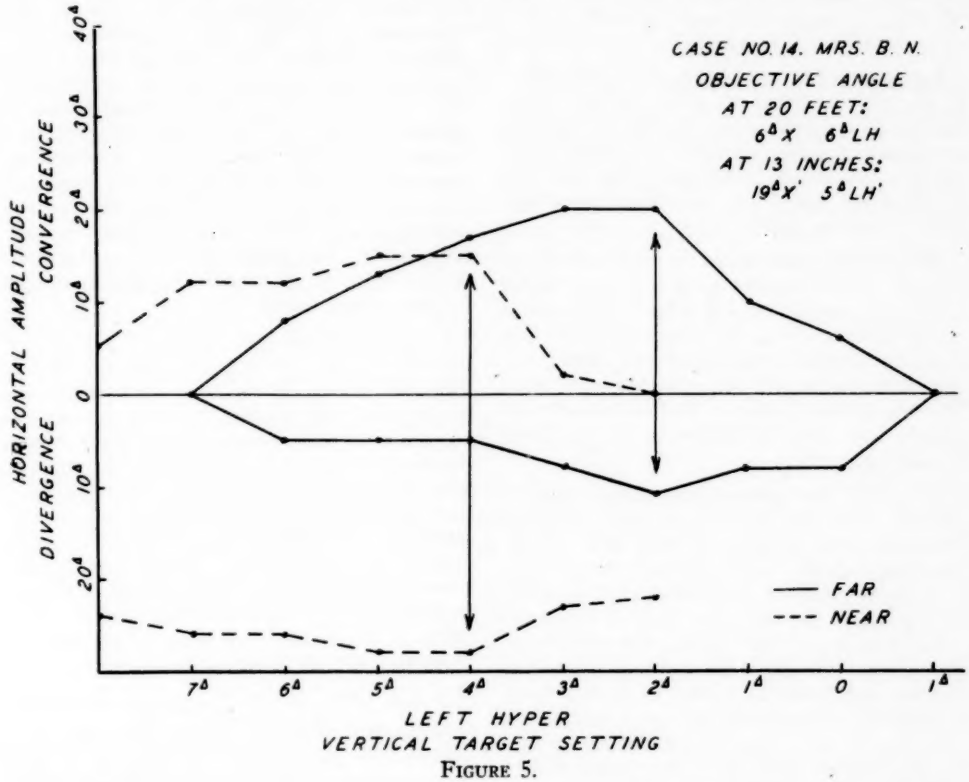

FIGURE 5.

If subsequent studies which we now have under way bear out the findings suggested in this preliminary report, the orthoptist will be able to make a valuable contribution to the ophthalmologist's treatment of hyperphoria. We have summarized the reasons why we believe this should be so, but will report on further studies at a later date.

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DISCUSSION

RICHARD G. SCOBEE, M.D., St. Louis, Mo.: It is rather difficult to add anything when discussing a paper written by one's immediate colleagues, for the discusser has been more or less intimately connected with the reported work and finds himself in agreement with the entire paper.

The finding that objective and subjective vertical measurements do not always agree on the Troposcope or any major amblyoscope is, of course, not a new one. It has been noted by almost every practicing orthoptist. The contribution of Miss Bennet and Miss Thompson lies, I believe, in their attempt to explain *why* such a difference should exist in many patients.

I can say from personal experience that the vertical level at which horizontal fusional amplitudes are greatest is that level which, when approximated with prisms, is most likely to result in comfortable binocularity. In some of the cases, the objective vertical measurement would be one figure, the subjective another, and the level of greatest horizontal fusional amplitude a third. It is this level of greatest horizontal fusional amplitude which is important to know in prescribing prisms for the patient with clinically significant hyperphoria. The authors have called it the *functional* hyperphoria, and I think the term is a good one.

It is not particularly surprising that the vertical setting permitting the greatest horizontal fusional amplitude is frequently about two-thirds of the objective finding. This is undoubtedly the source of the rule-of-thumb to correct two-thirds of the objectively measured hyperphoria with prisms, but the rule originated on a trial-and-error basis. He who first stumbled across it deserves a great deal of credit. Those who now explain the probable reasons why it should be true deserve no less credit.

The authors have emphasized that this is a preliminary report. It is to be hoped that they will pursue the problem further and in more detail because they can contribute greatly to our understanding and therapy of the patient with hyperphoria—the patient who, in the past, has in many instances suffered because of our lack of knowledge of exactly what to do for his condition.

KENNETH C. SWAN, M.D., Portland, Ore.: The authors have made a most interesting observation which may be of value in the determination of how large a prism to prescribe in patients with hyperphoria. They have observed that patients are comfortable when that vertical prism is prescribed which permits the widest amplitude of horizontal fusional movements on the major amblyoscope. Some might differ with the authors' explanation but it can not be disputed that vertical deviations may profoundly influence the amplitude of horizontal fusional movements. This phenomenon is well known to every orthoptic technician.

I agree that the best functional position of the visual axes is not always orthophoria. For this reason, it has been our custom to prescribe prisms in hyperphoric patients on the basis of measurements of fusional movements as well as by determination of the fusion-free positions; however, we have used vertical rather than horizontal fusional movements as our guide. In patients with small degrees of symptomatic concomitant hyperphoria, we prescribe a prism which equalizes deorsumvergence and sursumvergence. This prism is often less than vertical deviation as measured by the fusion-free position.

I have not had the opportunity systematically to correlate our method with that just reported by the authors; however, in reviewing our records I found several cases in which prescription of a prism which equalized the vertical vergences also resulted in marked improvement in the amplitude of horizontal fusional movements. This was illustrated by the case of Mr. J. B., who entered the University of Oregon Medical School Clinic with the complaint of a persistent headache. Examination revealed a concomitant hyperphoria for both distant and near fixation as shown in the accompanying data:

Mr. J.B. Age 39		cc: Headache	
Deviations	Fusion-free	3△	Left Hyper.
		3△	Eso.
	Extra foveal fusion	1△	Left Hyper.
		2△	Eso.

Prism Vergences uncorrected	Left Deorsum	4Δ
	Left Sursum	0
	Divergence	1½Δ
	Convergence	6-8Δ
With 2Δ Base: Down O.S.	Left Deorsum	2Δ
	Left Sursum	2Δ
	Divergence	2-3Δ
	Convergence	12-16Δ

℞ : 2Δ Base down relieved headache.

It is to be noted that this patient had vertical as well as horizontal fixation disparity, that is, there was a difference in the deviation measured in the presence of extrafoveal fusion and that determined in the fusion-free position. A prism was prescribed which equalized deorsumvergence and sursumvergence. This prism enhanced the patient's amplitude of horizontal fusional movements, eliminated vertical fixation disparity, and completely relieved his symptoms.

In the future, it is our plan to correlate the influence of vertical prism on both vertical and horizontal fusional movements. Whether the authors' method, ours, or a combination of both will prove most useful remains to be established, but I feel certain that the principle of determining the best functional position of the eye by a study of fusional movements provides a more logical basis for prescription of prisms than the arbitrary giving of a prism equal to half or two-thirds of the fusion-free deviation.

These two technicians are to be commended for observing and recording data beyond the scope of most routine orthoptic examinations. There is much to be learned about anomalies of binocular vision. Progress will be made only if we study all phenomena rather than simply follow a limited routine of tests in an attempt to fit all cases into standard classifications.

CONSTANT EXOTROPIA

DAVID M. FREEMAN, M.D.
ST. LOUIS, MO.

THE increased interest in problems of disturbances of ocular motility in recent years has resulted in several studies which are largely statistical in character. While these have yielded some answers to the problems met in the everyday handling of the individual case, there still exists a need for more information to guide us along the way. This report is based upon an analysis of records of patients with exotropia. The patients all had constant concomitant exotropia, thus excluding intermittent exotropia from consideration at this time.

The patients were seen either in the Washington University Motility Clinic or in the private practice of Dr. Richard G. Scobee. All data on patients from the Clinic were either collected by Dr. Scobee or under his supervision as chief of the Motility Clinic.

Ninety-six patients with constant concomitant exotropia were seen between 1946 and 1950. Of these 96, 31 had alternating exotropia and 65 had a monocular deviation.

In a study of this type, statistical generalizations based upon data from patients' records may be accepted only if one has a clear picture of the methods by which the data were obtained. Variability in results from one study to the next is usually due to variation in methods of collecting data, assuming the sample used is sufficiently large to be representative and assuming the statistical methods are the same. The following paragraphs describe, in summary fashion, the methods used.

Case histories were obtained from the patient or, in the case of children, from one or both parents. An attempt was made to ask no leading questions and answers were recorded for every case where the informant appeared reliable. In the case of adult patients, birth history was seldom available. When the patient was an adopted child, the family history and often the birth history were seldom known. Because of these facts, a complete case history was not available for all 96 patients in the sample.

Visual acuity determinations were made on Snellen-type letter charts, with the Illiterate-E chart used for young children. Far acuity was measured both with and without correction. Near acuity was not measured.

Refractive error was determined under atropine cycloplegia in children under the age of 12 years. Homatropine was used in patients between the ages of 12 and 40 years; no cycloplegia was used in patients over 40. In each patient, the correction prescribed was the least plus sphere (if hypermetropic) compatible with good comfortable vision or the full minus sphere (if myopic) together with the full cylindric findings, irrespective of sign of the cylinder.

Measurements of the deviation were made by the prism and cover test in both the primary and reading positions with and without glasses. Not all patients were wearing correcting lenses, but if glasses were worn or changed, at least four weeks had been allowed to elapse prior to making any measurement of the deviation. This period was allowed in

From the Department of Ophthalmology, Oscar Johnson Institute, Washington University School of Medicine.

Data used in this study were collected under a contract with the Office of Naval Research as Project N6onr-202, Task Order I, NR 141-022.

order that the accommodation-convergence ratio could become stabilized. If central fixation was poor or absent so that a cover test could not be performed, the deviation was measured on a perimeter which had a radius of 13 inches (27 cm.).

Limitations in ductions were noted, using an ophthalmoscope light moved into the six cardinal directions of gaze. Versions were studied and recorded for every patient. Even small vertical components were carefully sought and recorded when found.

The near point of convergence (NPC) was measured from the bridge of the nose. An ophthalmoscope light was used as the fixation target.

Additional measurements and studies were made when indicated to determine the presence of any structural or functional anomaly which might possibly be a factor in etiology or in determining the course of therapy.

Suppression amblyopia, when present, was treated by constant and complete occlusion, using the Elastoplast Occluder. No formal orthoptic treatment was given to any of the patients in this series.

Surgical treatment was given if the prescription of appropriate lenses failed to render the eyes at least cosmetically straight. The operation most frequently performed was a recession of the lateral rectus to the region of the equator (about 6 mm.) combined with a resection and advancement of the medial rectus on the same eye. Other operations were performed for some patients in the study, but only the technic of the recess-resect procedure will be described since it is the only one done in sufficient numbers to permit any analysis of the results.

In the recess-resect procedure as it was done, the recession of the lateral rectus was performed as described by Scobee.[4] In the case of the medial rectus, resection was confined to the tendon in order to prevent placing sutures in the belly of the muscle proper. Since the tendon of the medial rectus is seldom if ever more than 4.0 mm. in length, the average resection was slightly less than 3.0 mm. Advancement was always to within about 2.0 mm. of the limbus, and one 000 plain gut double-armed suture was used. None of the secondary attachments—check ligaments, intermuscular membrane, etc.—were cut except when it was necessary to do so in order to pull the muscle forward to its new insertion.

The recess-resect procedure was performed on the deviating eye in monocular exotropia and on the less dominant eye in patients with alternating exotropia unless the forced duction test[4] indicated that there might be some significant mechanical anomaly in one eye. If the forced duction test was positive, it was used as the criterion for selection of the eye to be operated upon. Both eyes were bandaged postoperatively for two days and the unoperated eye was left open on the third day. Convergence was encouraged after the first week. Postoperative measurements were seldom stabilized until the sixth to eighth postoperative week. The follow-up period was variable, but the shortest was at least two months while the longest was four years.

NONSURGICAL DATA

Exotropia has its onset most frequently at birth although the average age of onset for 80 patients was 6.8 years. Twenty-four per cent were exotropic from birth; thus the average age of onset is quite deceptive. Figure 1 shows the curve of incidence in relation to age.

The fact that a higher percentage of exotropia cases are present at birth than appear at any later time would seem to be significant and suggests that anatomic anomalies may be playing a prominent etiologic role in this type of case. Those patients whose exotropia appeared later in life are more likely to have innerva-

tional factors predominating. It is almost invariably true that when either exotropia or esotropia is present *at birth,* surgery is needed before a cure can be effected. Such deviations are seldom, if ever, purely accommodative.

The supposed precipitating cause for those cases of exotropia with an onset later in life than 6 months of age is frequently trauma. Frequently cited also were febrile diseases. There is often a discrepancy between the cause of a deviation according to the patient and according to the tenets of ocular physiology.

Premature birth was found in slightly more than 17 per cent of patients with exotropia; Scobee[5] reported an incidence of slightly more than 13 per cent in patients with esotropia. The incidence of premature births in the population as a whole is less than 4 per cent. The differences are probably significant, and the premature infant is certainly more prone to develop heterotropia than the infant carried to term.

Forceps delivery was performed in 24 per cent of the patients, but due to the popularity of "outlet forceps" deliveries, this finding is merely mentioned and no significance is attached to it.

The length of labor in 28 cases was slightly more than fourteen hours (average) although almost half of the 28 cases were born after a labor of less than eight hours. These data are of interest but are of doubtful significance.

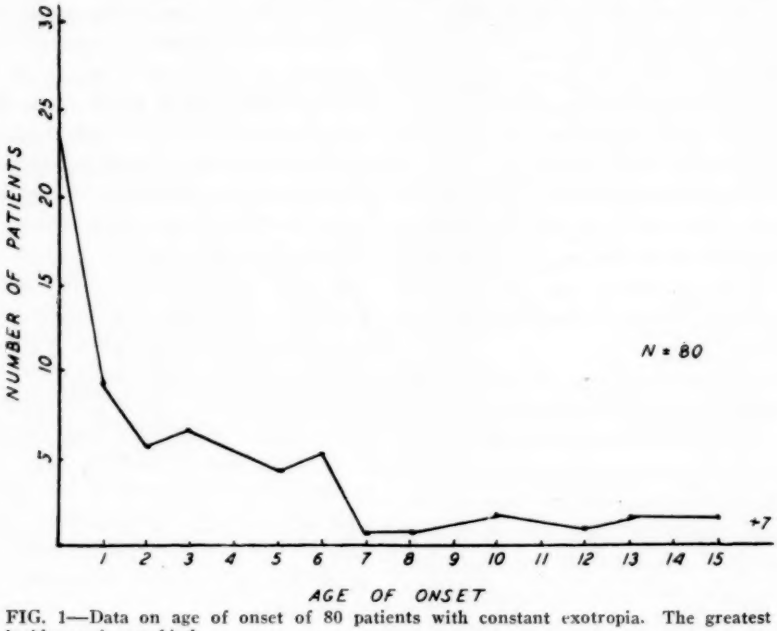

FIG. 1—Data on age of onset of 80 patients with constant exotropia. The greatest incidence is at birth.

With respect to familial incidence of heterotropia, 31 per cent of the patients in this series had one or more members of their immediate family with some sort of heterotropia. Scobee[5] found an over-all familial incidence of 41 per cent in 466 consecutive heterotropia cases from this same clinic.

The refractive errors found in exotropia are of interest. Certainly hypermetropia does not predominate in exotropia as it does in esotropia. The mean or average spherical equivalent of the refractive error of the dominant eye in this series was + 0.28 D, while that for

the nondominant or deviating eye was - 1.60 D. This is in distinct contrast to data for patients with esotropia.[5] Scobee found that the mean spherical equivalents ranged from + 1.12 D to + 4.01 D, depending upon the accommodative factor present. The tendency toward myopia in the deviating eye was expected but its exact amount was larger than had been anticipated.

Suppression amblyopia was found in 27 per cent of those cases with monocular exotropia. Only 17 per cent of the entire series of patients with exotropia had suppression amblyopia and this, of course, takes the alternators with suppression but no amblyopia into consideration. Occlusion was attempted in but

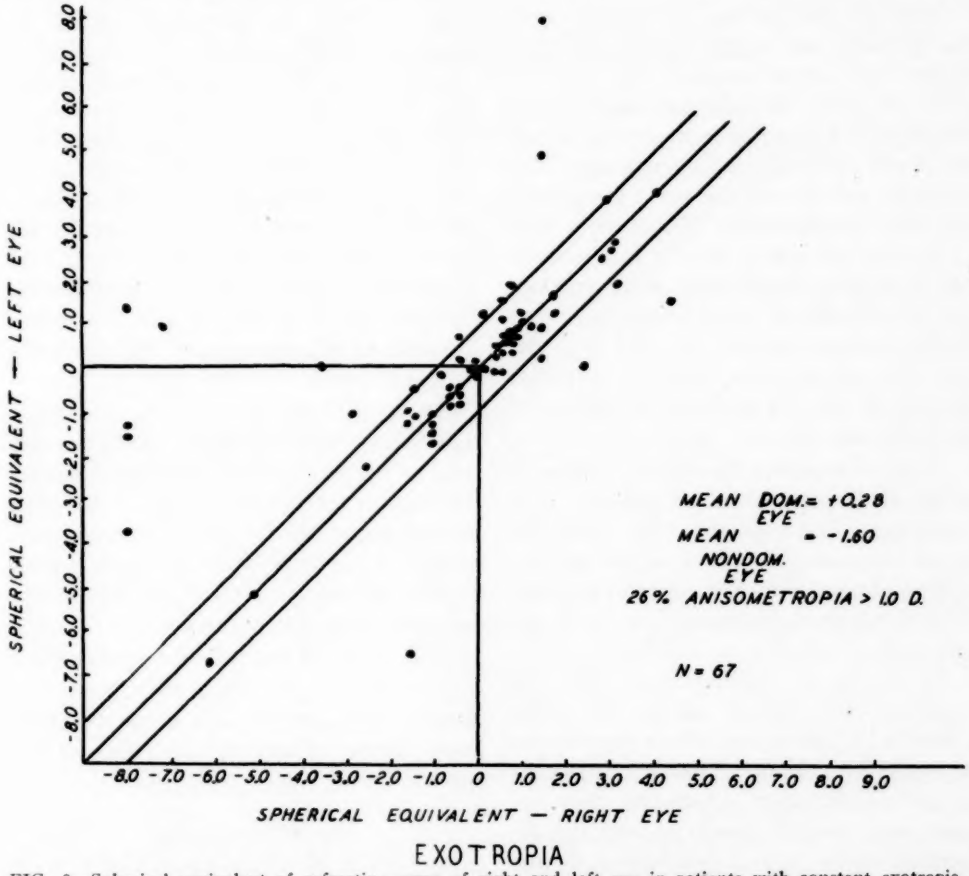

FIG. 2—Spherical equivalent of refractive error of right and left eye in patients with constant exotropia. The deviating eye had a mean or average error of −1.60 diopters. Twenty-six per cent of the patients had anisometropia greater than one diopter.

Anisometropia of one diopter or more was found in 26 per cent of cases (fig. 2). Anisometropia of similar amount is present in between 12 and 15 per cent of patients with esotropia[5] and the difference is apparently significant. Significant amounts of anisometropia are much more frequent in exotropia than in esotropia.

a few because a majority were adults who refused to submit to occlusion. Poor visual acuity in one eye (less than 20/40) was present in 48 per cent of patients and could be attributed to fundus lesions, refractive amblyopia, or opacities in the optical media.

The NPC measured from the bridge of the nose averaged 92 mm. for 80 patients. This is more remote than the average normal which is between 20 and 30 mm. No analysis of whether poor convergence was due to secondary convergence palsy or primary convergence insufficiency was attempted. In any event, the factor was not taken into account in planning surgery.

Vertical deviations associated with the primary and larger lateral deviation (exotropia) were common. Forty-three per cent had a definite and easily noted vertical component due to paresis of one or more vertically acting muscles. The inferior rectus was the most frequently involved single muscle. When more than one vertically acting muscle was paretic, the following three pairs were encountered with about equal frequency: (a) both elevators of one eye, (b) both depressors of one eye, and (c) superior rectus of one eye and inferior rectus of the opposite eye.

Scobee[5] reported a vertical component in about 43 per cent of 457 patients with esotropia. The superior rectus was the most frequently involved single muscle, followed closely by the superior oblique. For the paired involvements, both depressors of one eye led the list.

It should be recalled that defects in vertical conjugation which are associated with lateral deviations may be exaggerated on the one hand or partly concealed on the other, depending upon the particular muscle involved and the direction of the lateral deviation.[2] A vertically acting muscle may appear to be paretic on version studies and yet seem to regain its function miraculously following successful lateral surgery, when the position of the eyes is changed and the muscle gains greater vertical mechanical advantage. Occasionally, some vertical pareses may become evident after a lateral deviation is partly or completely corrected surgically; this has been noted by many investigators in both esotropia and exotropia but can usually be detected by careful preoperative studies.

That accommodation or the lack of it affects the amount of divergence in exotropia is obvious to all who work with problems in ocular motility. In analyzing these data, it was hoped that some indication of the frequency of an accommodative factor in exotropia might be gained. Unfortunately for statistical purposes, at least, almost none of the hypermetropic patients with exotropia were given glasses. One can, therefore, say nothing about the accommodative factor in such patients. In 49 patients on whom refractive data were available, 22 or slightly less than 50 per cent had a definite accommodative component. Scobee[5] found an accommodative factor present in 81 per cent of 456 patients with esotropia.

It seems likely that there is an accommodative element in exotropia in a much higher percentage than this series would indicate. One seldom attempts to alter convergence via the lever of accommodation in the hypermetropic person with exotropia since the effect would be one of increasing the exotropia.

No orthoptic analysis was performed on any of the patients in this group and hence there are no data about the sensory status of any of the cases in the group.

SURGICAL DATA

A total of 62 surgical procedures were done on this group of patients. Recession of a lateral rectus combined with resection and advancement of a medial rectus of the same eye was performed 46 times. The remainder were procedures on just one of the lateral rotators or one or more of the lateral rotators and one of the vertically acting muscles. The general technic of the recess-resect procedure has already been described.

The results are presented graphically in figure 3. On this scatter diagram is plotted the preoperative deviation in degrees against the degrees of correction; both measurements were made at 20 feet. It is evident that the same operation in 46 cases has yielded a wide range of corrections and that the amount of correction is more or less directly proportional to the amount of the deviation

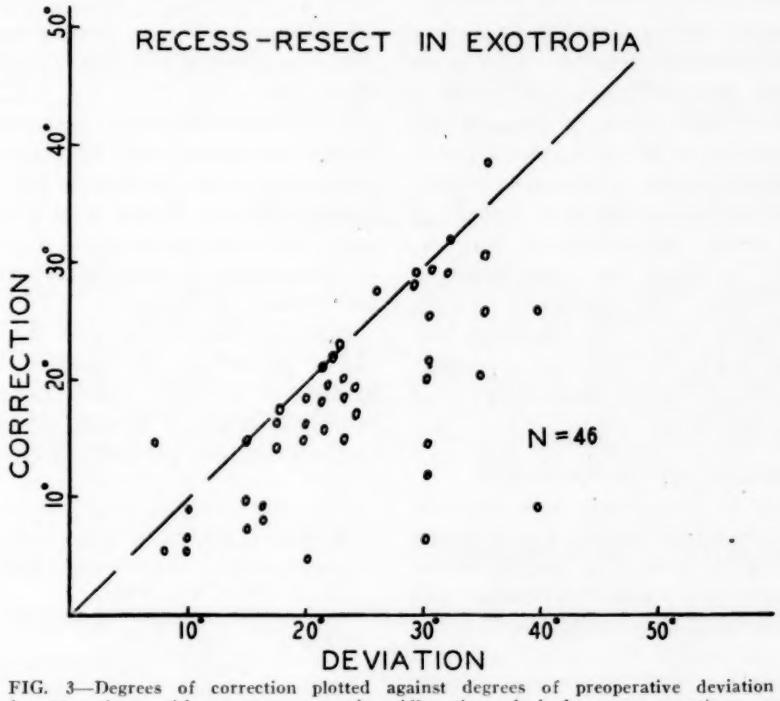

FIG. 3—Degrees of correction plotted against degrees of preoperative deviation for 46 patients with constant exotropia. All patients had the same operation.

present preoperatively. Scobee[5] has shown an even stronger relationship in esotropia for 175 cases. The large majority of operations in figure 3 can be seen to have resulted in undercorrections. Of interest, but absolutely no significance, is the average or mean correction, which was 18.2 degrees.

That there should be such a wide range of corrections from the same operation is perhaps surprising, but it indicates that the same operation does not have the same effect in each case. The surgeon may effect a shortening or lengthening of a muscle in terms of millimeters, but the muscles which are so treated are not necessarily the same with respect to size, elasticity, contractility, etc. Some of the muscles encountered are large and some are small, some are elastic and some are fibrotic and contracted. There are variations in the number and degree of secondary muscle insertions which might act as effective anchors preventing normal rotation of the globe, and certainly these secondary attachments will influence the position of rest of the eyes. This variation in the character and extent of the attachments partially explains the variability of the surgical corrections. One obtains a more effective leash effect from resecting and advancing a large elastic medial rectus than from doing the same thing to a thin, fibrotic one. Similarly, one finds secondary attachments on the lateral rec-

tus which act to prevent normal adduction of the eye, and their removal along with recession of the insertion will give more surgical effect than if they either were not present or were ignored. It would appear that anatomic anomalies account for some of the seeming variation in results. The greater the deviation, the greater the correction from the same operation in all cases.

The same operation might be expected to produce the same amount of correction in every case provided there were a direct relationship between degrees of correction and millimeters of surgery performed. The result of exactly the same operation in 46 cases is so variable that it seems unwise to attempt the prediction of a certain degree of correction from so many millimeters of surgery. Scobee[3,5] has made the same point in stronger terms. The amount of correction obtained from the operation described will usually be directly proportional to the amount of deviation present prior to surgery.

SUMMARY AND CONCLUSIONS

A study of 96 patients with constant exotropia has been made. The methods of nonsurgical as well as surgical treatment have been outlined in order that the conclusions may be properly evaluated.

Exotropia which is constant has its onset most frequently at birth. There are many apparent causes for exotropia appearing after the first six months of life but trauma and febrile diseases lead the list. The incidence of prematurity in patients with exotropia is significantly higher than in the general population. Thirty-one per cent of the patients with constant exotropia had heterotropia in their immediate family.

The mean spherical equivalent of the nondominant eye was - 1.60, while the fixing eye had a mean refractive error of + 0.28 D. Anisometropia greater than 1.0 D was found in 26 per cent of patients with constant exotropia. The NPC averaged slightly more than 9 cm., while suppression amblyopia was relatively uncommon and was found in only 17 per cent.

A vertical component was present in 43 per cent of the cases and the inferior rectus was most frequently paretic. An accommodative factor was present in more than half of the cases, but the exact percentage is uncertain because of the method of treatment.

Surgical data show that the recess-resect procedure produces a variable amount of correction and that the correction obtained is directly proportional to the deviation present preoperatively.

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AMERICAN ORTHOPTIC JOURNAL

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Subscriptions and requests for single copies should be addressed to the American Academy of Ophthalmology and Otolaryngology, 100 First Avenue Bldg., Rochester, Minn.

Editorials

FROM THE A.A.O.T.

IT is with pride touched with humility that we of the American Association of Orthoptic Technicians witness this first publication of the *American Orthoptic Journal.* This is an event in the life of orthoptics in America, testifying to a certain measure of attainment and growth in this particular field of which we are a part. In this our pride is justified.

We are gratefully aware, however, that making possible the over-all growth of our orthoptic work is the constant activity and vigilance of the American Orthoptic Council, to whom we turn for guidance and encouragement. We are ever mindful that were it not for the untiring efforts of the Council members and their interest, many of our problems would remain unsolved, and our progress would assume a slower pace and take a path less wise.

Our wish is to acknowledge in full our debt to the American Orthoptic Council and to express our pleasure in their attainment of the publication of the American Orthoptic Journal. Our appreciation of this progressive measure makes us keenly aware of our responsibility to orthoptic work as such and to our sponsors who so graciously support us. May we prove ourselves equal to meet the challenge of the future!

JEAN S. ROBINSON, *President*

ORTHOPTICS TODAY

IT has been eighteen years since the first orthoptic clinic in this country opened its doors. The American Association of Orthoptic Technicians celebrated its tenth anniversary last year. It would seem that orthoptics is well established by now and yet in the minds of many ophthalmologists, it is still at the cross-roads. Orthoptics has its ardent advocates and it has its violent critics. As is so often true, both are in error. There are plenty of data available to substantiate the worth of orthoptics in certain types of cases. Orthoptics will not, however, make the world turn around an extra time within twenty-four hours. Orthoptics has its limitations. Failure to recognize these limitations re-

flects no discredit upon orthoptics but upon the observer.

A knife and fork prove themselves useful tools three times a day; yet an ophthalmic surgeon would provoke only laughter from spectators if he attempted a cataract extraction with a table knife. Some of the patients referred to the orthoptist represent just as ludicrous and inept a selection in their way as is a table knife for a cataract extraction.

When positive evidence of cures is coming from many orthoptic laboratories—laboratories in which orthoptics is but a single tool and not the entire treatment—then one is inclined to look askance at the ophthalmologist who says, "I have never seen orthoptics cure a single patient." It is just possible that those who make this remark have never seen a saw build a whole house. Thousands of houses are built every year, however, using saws *and* hammers *and* nails *and* a lot of other tools. Without a saw, a majority of houses would never be built but a saw *alone* cannot build a house. Neither will orthoptics, which is merely a single tool, cure many patients with disturbances of ocular motility. On the other hand, there are a significant number of cases that would not be cured without orthoptics. "Cure" means the attainment of fusion and fusional reserve.

Constant occlusion of one eye has cured few disturbances of ocular motility; yet it is one form of treatment and has proven value in disrupting suppression amblyopia. Glasses alone will cure only 15 per cent of patients with esotropia; yet glasses will help 81 per cent. Surgery alone will cure a large number of cases of heterotropia, but it falls far short of curing them all. Orthoptics alone will cure few patients with heterotropia, but it can be a great help when employed intelligently as a single tool in treatment, properly combined with other tools.

If good results are to be gained with this tool that is orthoptics, then doctor and technician must work in close cooperation. Doctor and orthoptist are a team and they must work as one, with the doctor directing the play. Conferences should be held whenever indicated over a patient's progress or over his *lack* of it. Together, doctor and orthoptist can usually discover the reason for lack of progress and thus can usually do something about it.

One hears ophthalmologists complain that they refer a patient to the orthoptist and then do not hear from the patient for a year or two. The orthoptist is *partly* to blame. When, however, she refers the patient back to the doctor at frequent intervals and makes a complete report, with the usual result a "Hmmm. Oh, yes. Let's keep it up," she can hardly be blamed if the frequency of her return referrals decreases. If the ophthalmologist is ever to see a cure, he must take enough interest in the subject and in his patient to be able to interpret an orthoptic analysis and progress report properly and direct further treatment. The orthoptist is a technician. She is not a diagnostician. She can accomplish a great deal given suitable material with which to work and adequate instructions as to what is to be done. There are a few orthoptists who by their reading and study and work have become extremely competent even at diagnosis and this is to their credit. These are few, however. The majority of orthoptists are not diagnosticians, and certainly nothing in their training course would make them so. It is up to the medical profession to shoulder its share of the load. The attitude of "I have never seen a case cured by orthoptics" reveals the same profound thought on the part of the speaker as "I have never seen a house built entirely with a saw." The rejoinder is "And you probably never will."

THE AMERICAN ORTHOPTIC JOURNAL

The American Academy of Ophthalmology and Otolaryngology has been pleased to comply with the request of the American Orthoptic Council and the American Association of Orthoptic Technicians and is proud to publish this first issue of *The American Orthoptic Journal.*

The *Journal* will consist of papers read at the annual meeting of the American Association of Orthoptic Technicians, abstracts of literature, a roster of members, and editorials. In future issues outstanding papers read at regional meetings will be included.

As a supplement to the TRANSACTIONS, the *Journal* will be mailed to all members of the Academy and to all paying subscribers to the TRANSACTIONS without additional charge. It may be subscribed to separately for $2.00 annually, such subscription price to reach the office of the Academy at least 30 days before the scheduled date of publication. Only a small number of additional copies will be printed. These will be sold at the subscription price so long as the supply lasts.

ORTHOPTIC LECTURES

Twelve instruction courses at the graduate level, sponsored by the American Orthoptic Council through its Committee on Instruction, were made available to Orthoptic Technicians this year for the first time by the American Academy of Ophthalmology and Otolaryngology. A majority of those presenting courses were orthoptists who were willing to give their time and efforts to make this program a success. The courses were held on Monday and Tuesday mornings, October 15 and 16, during the Annual Session of the Academy.

The courses were open *only* to (1) members in good standing of the American Association of Orthoptic Technicians and (2) orthoptic technicians who have passed the examinations for certification by the American Orthoptic Council but have not yet been formally elected to membership in the American Association of Orthoptic Technicians.

The following courses were offered:

HOME TRAINING TECHNICS IN ORTHOPTICS
Mary W. Argue
Baltimore, Md.

OPTICS FOR THE ORTHOPTIST
Paul Boeder, Ph.D.
Southbridge, Mass.

THE TREATMENT OF SUPPRESSION AND AMBLYOPIA
Marjorie V. Enos
New York, N. Y.

THE ORTHOPTIC TREATMENT OF HETEROPHORIA IN ADULTS
Electra Healy
Chicago, Ill.

NEUROANATOMY FOR THE ORTHOPTIST
John W. Henderson, M.D.
Ann Arbor, Mich.

ORTHOPTIC TREATMENT OF VERTICAL DEVIATIONS
Mary E. Kramer
Kansas City, Mo.

DISSOCIATION TRAINING IN ACCOMMODATIVE HETEROTROPIA
Louisa W. Kramer
Washington, D. C.

STEPS TO FUSION
Julia E. Lancaster
San Francisco, Calif.

THE STEREOSCOPE AND ITS USES
Arthur Linksz, M.D.
New York, N. Y.

THE USAGE OF ORTHOPTIC INSTRUMENTS
Ann E. Stromberg
Boston, Mass.

THE BLIND-SPOT MECHANISM
Kenneth C. Swan, M.D.
Portland, Ore.

ANOMALOUS CORRESPONDENCE
Frances Walraven
Atlanta, Georgia

Abstract Department

MARY ARGUE, *Editor*

Only articles of interest primarily to the orthoptist are abstracted. A series of 34 classifications for such articles has been designed. There are not abstracts for each class in any one issue of the *Journal*. The classification follows.

The Abstract Editor would like to thank the following orthoptists for their help in compiling the abstracts:

Mrs. Marian Ritch White
Miss Marilyn Schroeder
Miss Sally Schaeffer
Miss Carolyn Pursley
Miss Dorothy Parkhill
Mrs. Ann Paul
Miss Elizabeth McLaughlin
Miss Joyce L. McEvers
Miss Nancy Capobianco
Mrs. Elizabeth Bennet Burroughs

CLASSIFICATION

1. Accommodation
2. Amblyopia
3. Anomalous Retinal Correspondence
4. Convergence
5. Cyclomovements and Deviations
6. Diagnosis
7. Diplopia
8. Divergence
9. Ductions
10. Esophoria
11. Esotropia
12. Etiology
13. Exophoria
14. Exotropia
15. Fusion
16. Heredity
17. Heterophoria
18. Heterotropia
19. Hyperphoria
20. Hypertropia
21. Instruments
22. Miscellaneous
23. Neuro-ophthalmology
24. Orthoptics
25. Paralysis
26. Refraction
27. Suppression
28. Surgery
29. Symptoms
30. Tests
31. Therapy
32. Vergences
33. Versions
34. Vision

2-1

Dyer, Dallas and Bierman, Edward O.: *Cortical potential changes in amblyopia ex anopsia,* Am. J. Ophth., 33: 1095-1098 (July) 1950.

The authors state that two theories stand out as the products of their intensive investigation of the condition:

1. That the amblyopic eye ceases to function normally, its physiologic functions are slowed, and its blood supply decreased.

2. That amblyopia develops from suppression into an active inhibitory reflex. (An inhibitory reflex is called into play because of the distracting result of simultaneous stimulation of disparate retinal points in the two eyes.)

Abraham (1932) postulated a decreased blood supply to the amblyopic eye because of the decreased function. Wald and Burian (1944) stated that since only form sense is suppressed and the retinal reaction to light is equal in the amblyopic and fixing eye, amblyopia must be produced in the cortex.

The method for tracing cortical patterns is stated and the types of cases studied are outlined. The authors believe that an active cortical disturbance is present in amblyopia (that is, an active inhibitory reflex), that there is a lessening of this disturbance in adults, and that the cortical disturbance may account for problem behavior in children with suppression amblyopia.

2-2

Oakes, I. Weston: *Squint amblyopia, its nature, diagnosis and effective treatment,* Am. J. Ophth., 33:1103-1107 (July) 1950.

Wald and Burian established that the light threshold was the same at the fovea and in the periphery in the amblyopic eye and in the dominant eye. They concluded from this that there was present in amblyopia ex anopsia a defect only in pattern vision.

Suppression is defined as a latent potentiality and, being basic but unstable, may be the primary condition out of which each of the other escape devices for diplopia evolves.

Binocular function is not present at birth, and depending on the stage at which the interference was inaugurated, the deviating eye will maintain that standard of stimulation. The nondominant eye is capable of being educated to overcome its degree of retardedness. The degree of retardedness does not seem to be based on the length of time that the amblyopia has been present.

Whether the squinter will develop amblyopia or an abnormal retinal correspondence seems to depend on (1) the age of onset and (2) the degree of determination to retain binocular function. Accurate diagnosis is essential.

The statements of Luther Peter are cited: (1) "Amblyopia is of frequent occurence in monocular esotropia. It is not present in the alternating type and but rarely in exotropia"; (2) "The amblyopia is limited to the macula and it is never absolute"; (3) "Treatment improves even the most profound cases."

If there is an *absolute* central scotoma we should seriously doubt that amblyopia ex anopsia is the cause.

"Continuous occlusion of the sound eye is the only thing of any importance," and "Unless begun in childhood or early teens it is of no value."

Seven objective points are raised: (1) occlusion of the better eye robs him of the ability to protect himself; (2) occlusion is often not available to adults for economic reasons; (3) the occluded eye must be watched (in children) to prevent its becoming the amblyopic one; (4) the adhesive dressing will become irksome and irritating; (5) most individuals will not tolerate restriction of activities; (6) unless the occlusion is complete the benefits are lost; and (7) it is a passive process, succeeding only to the extent that active effort is put forth to see with the amblyopic eye.

Innumerable facilities are at hand from which to design suitable exercises. The question of age as a barrier in improving the condition is raised.

3-1

Casari, Gianfranco: *Correspondenza retinica e terapia ortottica nello strabismo concomitante, Rassegna ital. d'ottal.*, 19:101-139 (March-April) 1950.

The author has determined the status of retinal correspondence on 90 patients with strabismus by means of the diplopia test, using the Maddox rod and the after-image test. The results were as follows:

In the 59 patients with convergent strabismus he found 32 patients with unharmonious anomalous correspondence, 20 with harmonious anomalous correspondence, and 6 with normal retinal correspondence.

In the 16 patients with exotropia he found 8 cases of unharmonious anomalous correspondence, 6 cases of harmonious anomalous correspondence, normal correspondence in 1 case and uncertain retinal correspondence in 1 case.

In the 15 cases of alternating strabismus including both convergent and divergent strabismus he found 2 cases with unharmonious anomalous correspondence, 8 cases of harmonious anomalous correspondence, and normal retinal correspondence in 5 cases.

The author also reports his findings regarding a functional cure in these patients attempted with (a) orthoptic exercises alone, and (b) a combination of orthoptic exercises and surgery. The orthoptic exercises were carried out with a stereoscope and with a diploscope. Sometimes bar reading was added.

When orthoptic treatment alone was used the retinal correspondence became normal in 7.5 per cent of the cases treated. Of the cases in which surgery was added to the exercises, 24.1 per cent of the patients so treated acquired normal correspondence. Of the 16 cases with divergent strabismus, of whom 14 had abnormal retinal correspondence, none achieved normal correspondence with exercises alone, while of the 2 cases treated surgically one acquired normal correspondence.

Of the 15 cases with alternating strabismus, not one case obtained normal correspondence with the exercises alone, while normal correspondence was achieved by surgery in 33 per cent of the cases.

The author states concerning the exercises, "At the most I did exercises with the patients every other day for 20 to 40 minutes with the stereoscope and the diploscope. I have later tried to consolidate the results with exercises without instruments, above all by means of the well known method of bar reading. I only rarely used atropinization or bandaging of the better eye, and in general not beyond 30 to 40 days, preferring instead to use true and, properly speaking, orthoptic exercises. I have interrupted the exercises when the patient showed no tendency whatever toward binocular vision nor normalization of the retinal correspondence after 50 to 60 days of lessons."

3-2

Enos, Marjorie V.: *Anomalous correspondence,* Am. J. Ophth., 33:1907, 1950.

The author defines anomalous correspondence as a cerebral act which associates two noncorresponding areas in the retinas so that a single image is visualized by the squinter. She cites a number of studies of the frequency of anomalous correspondence, finding the average for the entire group to be 47.5 per cent. In a series of 295 cases of her own, 45 per cent had anomalous correspondence; 53 per cent of those with esotropia, but only 16 per cent of those with exotropia, had anomalous correspondence. She believes that anomalous correspondence is acquired rather than congenital.

Miss Enos considers a difference of more than 5 prism diopters between objective and subjective angle indicative of anomalous correspondence, using a major amblyoscope for the study.

She discusses the patient who acts as if he has anomalous correspondence on first grade targets, and yet who can fuse second grade slides at the objective angle and may even show stereopsis. The author believes that the anomalous correspondence in these cases is not firmly established and that the prognosis is good.

The diagnosis of anomalous correspondence by the after-image test, the double-image test, and on a major amblyoscope is described in detail. The Lancaster red-green test is also discussed.

The goal of treatment in anomalous correspondence is one of teaching the patient true correspondence by arousing in him an appreciation of the correct relationship of his two foveas at his objective angle. Several treatment technics are given in detail, including an excellent description of the Walraven technic. The author endorses the latter technic and believes that six training sessions will effect a change if orthoptics can do anything at all.

3-3

Stephenson, R. W.: *Abnormal retinal correspondence,* Tr. Ophth. Soc. U. Kingdom, 49:549-557, 1950.

The author describes the clinical aspects and treatment of abnormal retinal correspondence cases that have come under his care during the past two years.

Abnormal retinal correspondence is a condition that develops slowly and at first is not deeply rooted. It is a preventable condition and the number of cases occurring should diminish as facilities for squint treatment develop. The author found that the condition is likely to develop in a lively, adaptable child with a fussy, "nervy" home background.

There are also certain factors that seem to have no effect on the development of abnormal retinal correspondence, such as angle of squint, refractive error, visual acuity, heredity, and accommodative element.

When the patient is seen by the ophthalmologist for the first time, an atropine refraction should be done and the full correction given. After the glasses have been given, the patient is referred to the orthoptic clinic where the treatment is divided into curative and prophylactic.

Occlusion plays a very important part in the prevention and the treatment of abnormal retinal correspondence. Even after surgery, if the eyes are not yet parallel or if fusion is not immediately obtained, occlusion should be used.

The author does not put too much stress on measurements for surgical procedures. The maximum amount of recession is always done except in squints under 12 to 15 degrees. In such cases the amount recessed depends upon the size of the muscle.

Orthoptics is started soon after surgery. In cases that have had a recession operation, orthoptics is started four days after surgery. Patients who had surgery on both muscles are seen in the orthoptic clinic ten days after surgery.

For the prevention of abnormal retinal correspondence in cases of strabismus, the author stresses (1) the use of occlusion in every case that is likely to develop abnormal retinal correspondence until the two foveas are used together, and (2) early surgery.

These principles apply not only to abnormal retinal correspondence but to the treatment of cases of convergence which is not purely accommodative.

3-4

Strazzi, A.: *La correspondenza retinica nello strabismo fuzionale,* Boll. d'ocul., 29:517-526 (Aug.) 1950.

A study with the Maddox rod, Maddox cross, and after-image test on 80 patients, of whom 60 had monocular strabismus and 20 alternating strabismus, showed that 65 per cent of the patients with monocular strabismus had abnormal retinal correspondence. Only one-fifth of the cases had harmonious ab-

normal retinal correspondence, and normal retinal correspondence was found in 5 cases of periodic strabismus of the accommodative type. It was also noted that 14 of the 20 cases with alternating strabismus had normal retinal correspondence. The age group of the 6 showing abnormal retinal correspondence was 13 years and older. The other 14 patients were 12 years and younger.

Abnormal retinal correspondence seemed to predominate in patients with amblyopia.

The author believes that patients cannot have fusion with abnormal retinal correspondence because of the suppression and the difference in acuity of the retinal areas in the two eyes.

Abnormal retinal correspondence is a passive mental adjustment without any particular purpose.

3-5

Travers, T. a'B.: *The practical importance of abnormal retinal correspondence,* Tr. Am. Acad. Ophth., 54: 561-564 (May-June) 1950.

There are three aims in the treatment of any case of squint: (1) good vision in each eye; (2) straight eyes; and (3) normal binocular vision. These aims should be attained without surgery if possible. Abnormal retinal correspondence is a defect of binocular vision and its presence is a bar to the attainment of the third aim.

Dr. Travers says that after diagnosing the type of correspondence—normal or abnormal —one needs no further information. What is important is that the patient with abnormal retinal correspondence cannot project his two macular images in the same direction at the same time; therefore, he cannot be given fusion exercises. Orthoptic exercises are concerned with fusion of the two macular areas only.

If the correspondence is normal, it is reasonable to try orthoptic exercises to increase the power of fusion.

Four suggested methods of treatment of abnormal retinal correspondence are: alternating occlusion, prisms, orthoptic exercises, and surgery. The first three are of doubtful use. If surgery is done before 3 years of age, there is reasonable expectation that normal binocular vision will develop. One often sees correspondence change or lessen. After 4 years of age, normal binocular vision is seldom attained. Abnormal retinal correspondence gives an absolute indication for surgery if the squint is large enough to be unsightly.

Dr. Travers summarizes his paper as follows:

1. Abnormal retinal correspondence is a defect of binocular vision.
2. Its diagnosis is easy—by proof if the patient is cooperative; by probability if he is too young.
3. The only satisfactory method of treating abnormal retinal correspondence is corrective surgery.
4. Once a diagnosis of abnormal retinal correspondence is made, surgery is desirable if the squint is large enough.
5. A diagnosis of the type of correspondence present is very helpful in deciding the general course of treatment.

3-6

Yoxall, Mrs. D. E.: *Treatment of abnormal retinal correspondence,* Tr. Ophth. Soc. U. Kingdom, 49:559-566, 1950.

In the group that is old enough to cooperate, not much time is wasted preoperatively in the treatment of abnormal retinal correspondence as it does not seem to help the time factor or final result to obtain normal retinal correspondence before operation. Patients are referred to surgery as soon as the visual acuity is equal and a definite diagnosis of abnormal retinal correspondence has been made. Orthoptic treatment is started on the fifth to the twelfth postoperative day depending upon the surgical procedure.

Young children are occluded until they are old enough to cooperate or until after operation. In these cases, unless the surgeon is accurate the operation may be wasted from the point of view of abnormal retinal correspondence and the final result.

Postoperatively the treatment consists of working on the synoptophore with the machine set at 0 or at the "parallel axis." The patient is not allowed to converge or diverge on the machine. Only at the "parallel axis" will the patient show true retinal correspondence. The orthoptist finds that the patient can overcome a small residual angle within one or two weeks postoperatively, but until he can overcome this residual angle he should not be allowed to use his two eyes together off the synoptophore.

Simple fusion targets are used first; it is easier for the patient to fuse similar slides than S.M.P. slides. Movement of the arms of the synoptophore by the orthoptist is not encouraged; the patient should be encouraged to fuse by the use of his eyes.

4-1

Mellick, A.: *Convergence deficiency,* Brit. J. Ophth., 34:41-64 (Jan.) 1950.

The author presents an investigation of 88 patients with objective and subjective features of convergence deficiency. Fifty-one patients were females, and 37 patients were males. The ages ranged from 14 to 50 years. Fifteen of the 88 cases were unsuitable for treatment because of functional nervous disorder. Of the 63 patients that completed the treatment, 48 were considered neurotic and 6 had symptoms following an acute illness; the other 9 had no apparent illness. Thirty-seven of the neurotic group were cured, 4 were improved and 7 made no progress at all.

The author found that relief from symptoms was followed by improvement of objective signs. In some cases the patients improved objectively but still had symptoms.

The normal amount of convergence used is 21 prism diopters. Individuals having only 21 prism diopters of convergence are using their maximum amount of convergence. For comfort, more is required. The author found 18 patients who had 21 prism diopters of convergence, and even less, doing close work without any symptoms! "The explanation for the absence of symptoms is not as yet evident."

A group of 29 patients with corrected refraction and a normal amount of phoria and ductions complained of symptoms. The age varied from 15 to 56 years. Of the 29, 14 were doing close work.

The author discusses the various views as to the relationship between convergence function, the general condition of the patient, and the permanent effect of orthoptic treatment. He states that a majority of writers agree that considerable benefit and cure can be obtained by orthoptic exercises. The influence and personality of the ophthalmologist and orthoptist play an important role in treating these patients.

Fatigability of convergence was investigated in several patients. After the patients were examined they were allowed to read until symptoms reappeared; then measurements were repeated. No difference was found.

4-2

Tait, E. F.: *Stimulus-response mechanisms in binocular coordination,* Am. J. Ophth., 33:1751, 1950.

The article is a consideration of binocular coordination from the viewpoint of reflex arcs or stimulus-response mechanisms which are involved. The author questions the validity of terminology such as convergence insufficiency and divergence excess.

According to Tait, there are four basic reflexes concerned with the position of the eyes:

1. Tonic vergence: the position of the eyes when the only innervations to the ocular muscles are from "the tonic center," unmodified by accommodation, fusional or proximal stimuli. Tonic vergence itself is a composite of a number of reflexes.

2. Fusional vergence: modification of ocular position produced by the fusional processes in the distribution of tonic reciprocal innervation to the extraocular muscles in order to gain or maintain single binocular vision when the individual is not orthophoric for the fixation point.

3. Accommodative convergence: convergence resulting from accommodative activity. It is present only when fusional vergence has been destroyed by dissociation.

4. Proximal convergence: stimulated by a sense of nearness.

Tait says that heterophoria or comitant heterotropia for far must be due to deficiencies in the distribution of tonic reciprocal innervation if fusional, accommodative, and proximal stimuli are eliminated; such deviations can seldom be modified by orthoptics, in the author's experience. He would place all disturbances of motility into one of three categories: (1) abnormal tonic vergence, (2) deficiencies in amplitude of fusional vergence, and (3) excessive accommodative convergence.

Tait believes that orthoptics can accomplish a great deal in the patient with heterophoria with symptoms. Orthoptics accomplish much less in heterotropia unless it is purely accommodative. Orthoptic methods are either physiologic or psychologic. The essayist concludes by stating five laws of learning: primacy, recency, vividness, frequency, and emotional congruency, and states that they are applicable to orthoptic procedures.

5-1

Moses, Robert A.: *Torsion of the eye on oblique gaze,* Arch. Ophth., 44:136-139 (July) 1950.

The author shows that torsion of the eye does occur on oblique gaze. He shows through a direct experimental approach that on up-and-out and down-and-in gaze the sagittal meridian is extorted. In the other two oblique directions it is intorted. The amount of torsion is of the order of magnitude pre-

dicted by Maddox, based on Listing's Law. Also, torsion is correctly represented by the tilting of the afterimage.

6-1

Ambrose, A.: *Errors in illustrations and definitions of actions of extraocular muscles,* Am. J. Ophth., 33:793, 1950.

According to Ambrose, there is a discrepancy between textbook illustrations and the true actions of the extraocular muscles. He prefers a method of recording in which the patient appears to be facing the examiner so that the patient's right is the examiner's left.

He coins a term, "the eternal muscle triangle," which includes a paretic muscle, its direct antagonist, and its yoke muscle.

The author believes that the most important action of a muscle is that which it exercises in its field of greatest mechanical efficiency. Thus, the right superior rectus is most important in moving the right eye upward; the fact that it has secondary actions is relatively unimportant.

Ambrose presents a diagram depicting the actions of the muscles of both eyes as agonists, antagonists, synergists, and yoke muscles. He concludes by citing errors in several standard ophthalmic textbooks.

6-2

Giotta, Peter J.: *Differential diagnosis of paresis of superior oblique and superior rectus muscles,* Arch. Ophth., 43:1-8 (Jan.) 1950.

Six cases of strabismus with head tilt were studied. The author chose cases with binocular single vision with typical findings. In patients with atypical findings without binocular vision there was usually an amblyopia present which the author believed was accountable for the variability in the measurements. The consistent secondary and primary deviations noted in the cases presented were of importance in demonstrating that the positive head-tilt tests were due to a weakness of the superior oblique muscle and not to an overaction of the inferior oblique muscle in the same eye secondary to an initial paresis of the contralateral superior rectus muscle.

7-1

Tabor, George L., Jr.: *Intractable postoperative diplopia,* Arch. Ophth., 44: 517-522 (Oct.) 1950.

In the analysis of cases of intractable postoperative diplopia it was found that one or more of the following factors may be present in any individual case: (1) anomalous retinal correspondence with or without amblyopia; (2) congenital or developmental deficiency of fusion, that is, complete absence of sensorial correspondence between the two eyes; (3) incongruence of the retinal images (aniseikonia); and (4) a psychogenic factor.

The author feels that the most helpful finding before operation in determining the possibility of postoperative diplopia is the absence of fusion of macular images with considerable unsteadiness of the double images.

Follow-up treatment, if postoperative intractable diplopia occurs, should include (1) orthoptic exercises, (2) training in suppression, (3) overcorrection in refractive error in one eye or complete occlusion, and (4) restoration of original squint by another operation.

Intractable postoperative diplopia occurs almost exclusively in adults, or in late childhood.

11-1

Posner, A.: *Management of a case of intermittent convergent strabismus,* Eye, Ear, Nose and Throat Monthly, 29:35, 1950.

The case history of a 5-year old boy having 30 degree convergent strabismus since the age of 2 is given. Upon examination under atropine the deviation remained unchanged or increased slightly. Refraction under cycloplegia showed hypermetropia of 4.00D in the right eye and 5.00D in the left eye. After wearing 1.00D less than this correction in each eye, the patient had no deviation of his eyes except with extreme fatigue.

It is pointed out that cycloplegia does not eliminate strabismus. Under atropine the accommodative effort is made ineffectual but the center of accommodation is not paralyzed. If accommodative efforts are put forth under cycloplegia, the convergent strabismus will remain. There is a definite relationship between such action and the temperament of the patient. In discussing the use of miotics as a means of therapy in convergent strabismus, the author points out that in certain cases it serves a temporary but useful measure.

11-2

Vaughton, G. and Stewart, M.: *Treatment of convergent strabismus associated with hypermetropia,* Brit. J. Ophth., 34:212-220 (April) 1950.

In cases of convergent strabismus associated with hypermetropia, successful orthoptic treat-

ment depends upon the full atropine correction given to the patient with manifest or latent hyperopia.

The points in favor of full correction are (1) the need for excessive accommodation is removed, and facility with which the child overconverges is curtailed; (2) the angle of squint is removed unless there is any tonic element, and the cases can be cured by orthoptic treatment alone; (3) suppression is greatly reduced; and (4) full correction minimizes the chance of an abnormal retinal correspondence developing.

The types of squint that benefit from wearing a full correction are (1) variable angle of squint; (2) cases of overconvergence when fixing a distant object; (3) cases of overconvergence when fixing a near object; (4) cases of small convergent angles with no binocular vision which attempt a false association fixation at 0; (5) cases of intense central suppression which do not yield to treatment; (6) cases that have S.P. but are unable to develop fusion owing to the continual slight "slipping off" of one eye; and (7) enlarged pupils which do not contract during effort to accommodate or converge, associated with absence of normal adduction and convergence.

A disturbance of accommodation was found in young patients who were not given a full correction. They suffered from fatigue of accommodation. The fatigue manifests itself in (1) enlarged pupils which contract to light and do not do so to accommodation, and (2) lack of proper convergence.

Part of the treatment for the patients wearing a full correction is to train the adduction as soon as fusion develops. By working on the adduction rather than the abduction, fusion becomes "strong" more rapidly, suppression is eliminated and stereoscopic vision is developed. The authors have not found that the angle of convergence increases with this method.

12

Lavery, F. S.: *Observations on the etiology and treatment of concomitant strabismus,* Tr. Ophth. Soc. U. Kingdom, 69:607-614, 1950.

Lavery considers the role of hypermetropia in the etiology of strabismus and points to the well-known facts which indicate that hypermetropia may be an exciting cause for the condition but does not give the full explanation of the cases.

He discusses anatomic factors as an etiologic cause and states that it appears to him that the variations in the insertions of the muscles have little or no bearing on the occurrence of strabismus, judging from his experience at the operating table. While in some cases a paralytic origin of a convergent strabismus may be assumed, these cases are rare. According to Lavery, the basic factor in the production of squint is to be found in an upset of the function of the higher cerebral centers. In this connection he discusses how interference with cerebral dominance produced by changing handedness is the cause of the majority of cases of stammering, and he feels that strabismus may be another manifestation of an upset of cerebral dominance.

It is Lavery's experience that the number of cases in which a cure is brought about by orthoptics is very few. He feels that convergence is the only ocular movement that can be increased by orthoptic exercises.

He recommends a short course of fusion training at the angle of squint where the visual acuity is sufficiently good in both eyes. He believes that postoperative treatment is of value and that it should be directed mainly toward increasing convergence. He believes that the maximum benefit is obtained in some six to ten treatments and that longer courses are a waste of time.

Lavery advises early surgery and considers 3½ years to be the optimum age.

15

Marg, Elwin and Morgan, Meredith W., Jr.: *The pupillary fusion reflex,* Arch. Ophth., 43:871-878, 1950.

The pupillary fusion reflex as first published by Schubert and Burian in 1936 was critically tested by a haploscopic method using infra-red photography and a Babal optometer for measurement of accommodation. Eleven subjects examined showed no indication of pupillary fusion reflex. It would appear that the reflex originally discovered was an artefact which might easily occur without strict control of accommodation, illumination and convergence.

16

Strazzi, A.: *L'importanza dell'ambliopia nello strabismo ereditario,* Bull. d'ocul., 29:527-536 (Aug.) 1950.

The author discusses the hereditary factors in families with amblyopia and strabismus.

One woman, aged 43, had 10 degrees of left esotropia. Her right eye was normal. Visual acuity in the left was limited to hand movements. The left eye was microphthalmic and had a coloboma of both iris and choroid.

Her son had an esotropia of 25 degrees soon after birth; when he reached the age of 5, his visual acuity was found to be normal in the right eye, but 3/50 in the left eye. She also had identical twin girls, both with a left esotropia and a deep amblyopia in the left eye. The refractive error was very small in all three children.

A second family observed by the author included a grandmother, aged 55, with a left esotropia of 15 degrees and a deep amblyopia. Her daughter had 15 degrees of left esotropia with almost no refractive error and deep amblyopia in the left eye. The granddaughter also had left esotropia with amblyopia in the left eye.

The author believes that at birth all children have binocular amblyopia. Through repeated stimulation of visual reflexes, normal visual acuity develops. He believes that amblyopia is congenital and not acquired. He also believes that amblyopia is a major cause of strabismus and not a consequence. He points out that there seems to be little relationship between amblyopia and strabismus and that there are many factors which play an important etiologic role in the latter, the most important of these being amblyopia. He believes that there is a defective "faculty" in the brain for receiving retinal images, that this defect is hereditary, and that strabismus is a result of this defect, which is really congenital amblyopia.

18

Evans, P. J.: *Squint in children,* M. Press, 224 (2) :49-52 (July 12) 1950.

The author describes the management and treatment of pseudo and manifest strabismus.

Patients with a manifest squint, whether monocular or alternating strabismus, are given an atropine refraction and the full correction is prescribed if the patient is hypermetropic. Occlusion is started if amblyopia is present, and further treatment is not decided until the visual acuity is equalized.

The author does not believe that cases of alternating strabismus are suitable for orthoptic training if the patient has equal vision or equal error of refraction, the angle of squint measures the same with and without correction, and fusion is nonexistent. These cases may prove disadvantageous in developing diplopia, which may be persistent. In these cases early surgery should be done for cosmetic effect. Surgery should be done as early as possible since this may encourage development of spontaneous fusion. However, depending upon the circumstances, surgery may be deferred until 5 or 6 years of age, when a child can benefit by orthoptic exercises.

The orthoptic treatment consists of (1) occlusion in amblyopic cases and (2) the initiation or strengthening of binocular vision. The author is doubtful whether this faculty can be initiated by exercises; when fusion is weak, however, it can be developed.

19

Scobee, Richard G. and Bennet, Elizabeth A.: *Hyperphoria,* Arch. Ophth., 43:458-465, 1950.

A series of 1,476 consecutive patients were examined for hyperphoria by using the Maddox rod test; 521 patients had 0.5 prism diopter or more of hyperphoria. Clinical significance of the hyperphoria was judged primarily on the basis of associated symptoms. From the results in the series examined, 1 of every 3 patients may be expected to have 0.5 prism diopter or more of hyperphoria, but only 1 of 20 will have a hyperphoria of clinical significance. There was no significant relation between age and the presence of a lateral imbalance on the clinically significant hyperphoria. The visual acuity was equal in 85 per cent of the patients examined. In 82 per cent of the cases studied, it was found that the manifest hyperphoria did not increase after wearing the prisms for not less than one year. The inferior oblique muscle was found to be the most frequently involved, followed by the superior oblique, superior rectus and the inferior rectus. Contrary to the publications of White, the authors believe the most frequent cause of hyperphoria is probably innervational rather than paretic.

21-1

Costenbader, Frank D.: *The accommodometer,* Tr. Am. Acad. Ophth., 54: 362 (March-April) 1950.

Dr. Costenbader describes the accommodometer, which is an instrument designed to test accommodation, test near vision, and aid both in the examination and treatment of accommodative convergent strabismus cases. This instrument has a black handle with a notch so that the enclosed circular disc may be rotated with the thumb. Symbols of regularly increasing and decreasing size are mounted on the disc and appear in an aperture in the handle as the examination progresses.

The instrument has the following advantages:

1. There are readily changeable and recognizable symbols.
2. The instrument is easily operated with one hand for nearly all tests and uses.
3. While only one symbol is apparent to the patient at one time (making memorization difficult), the same symbol, as well as the preceding ones, are simultaneously visible to the examiner.
4. The measurements for the punctum proximum may be read directly from a tape.
5. Interest, attention, and accommodative effort may be maintained throughout the test by frequently changing the symbols both in character and size.

21-2

Lancaster, Walter B.: *The red-green test,* Tr. Am. Acad. Ophth., 54:367 (March-April) 1950.

Dr. Lancaster describes his red-green test for measuring ocular deviations. It excels in the ease of application, accuracy of measurement and speed. It consists of two light projection units and a pair of goggles containing colored disks or filters—red for the right eye and green for the left. A tangent screen, marked off in 70 mm. squares, is optional.

21-3

Krimsky, Emanuel: *A multiple prism holder,* Tr. Am. Acad. Ophth., 54: 371 (March-April) 1950.

Dr. Krimsky describes the multiple prism, which combines the advantages of the single prism holder plus an added feature which enables one to lock one or two prisms selectively in horizontal or vertical position, as in a case of ocular deviation having both horizontal and vertical components. The examiner is then free to operate a flashlight in one hand and a cover or a hand rotary prism in the other. Such combinations of prisms help the examiner to observe the effects of prisms on the eye as well as on the corneal reflex.

21-4

Krimsky, Emanuel: *The stepladder prism,* Tr. Am. Acad. Ophth., 54:369 (March-April) 1950.

The stepladder prism enables one to use a single prism bar either horizontally or vertically. It is not intended to replace the plastic or glass prism rack. It is practical because it incorporates prisms of two or three strengths into a single square prism bar of standard dimensions. The stepladder prism can be made in different desired strengths or combinations.

21-5

Krimsky, Emanuel: *Ferris wheel attachments for the Brewster-type stereoscope,* Am. J. Ophth., 33:1444-1445 (Sept.) 1950.

The aim of the attachments is to provide, on a pair of circular discs, a series of stereoscope pictures which can be rotated into position for viewing.

By means of a handle which operates a right and a left hand tread, these discs can be separated so as to diverge the pictures as well as the eyes; or they can be approximated so as to converge the pictures as well as the eyes. Also, the discs can be brought synchronously closer to or drawn away from the eyes for selective increased or reduced accommodative ranges.

A comprehensive set of targets is complete on one disc and this aids in the efficiency of treatment.

22-1

Geis: *Schielen im Kindesalter und sein Einfluss auf die Entwicklung des Charakters* (Strabismus in childhood and its effect on the development of the character), Deutsche Gesundheitswesen, 5:273-276, 1950.

The author states that strabismus presents more than a cosmetic disfigurement. He discusses the impressions given by the various kinds of strabismus. A small amount of divergent strabismus in a young woman gives the impression of coquetry, while an alternating esotropia causes an impression of hypocrisy, and a downward deviation gives the impression of superciliousness.

Early treatment is highly recommended. Glasses should be given as soon as possible, even to a child 1 or 2 years of age. At an early age, if it is not possible to give orthoptic exercises, prisms could be added on each side of the glass of about 8 to 10 prism diopters in order to assist the fusion tendency. Occlusion is recommended in cases of amblyopia. If occlusion is not possible, the better eye should be atropinized. In addition, the author recommends exercises. Surgery should be done early and exercises started immediately after removing the bandages.

22-2

Posner, A.: *Effects of television on the eyes,* Eye, Ear, Nose and Throat Monthly, 29:261, 1950.

Well-defined pictures should not produce any strain except in an individual whose labile nervous system is subject to rapid fatigue. The mind serves as a safety valve to prevent injury to the eyes, since mental fatigue precedes eye fatigue. If common sense is used, there is no harm in allowing a child to watch the screen at close range, and in amblyopia this is most helpful.

24-1

Barbosa Da Luz: *A reeducacao visual dos estrabicos. Resultados obtidos eim 143 casos de Estrabismo, no "Departamento Ortoptico" da Clinica Paulo Filho* (Visual reeducation of patients with strabismus), Rev. brasil oftal., 8:41-58, 1949.

The author reports on the results obtained in the orthoptic department of the Clinic Paulo Filho, which was started two years ago. One hundred forty-three patients were referred to the orthoptic clinic: Of these, 63 had completed the treatment at the time that the report was submitted.

The author states that 44.7 per cent of the patients declined orthoptic as well as surgical treatment. This may be due to the fact that the patients were largely adolescent. He believes that adolescents are more likely to decline the treatment, and that this is an added reason why treatment should be instituted between the ages of 3 and 5 years.

Of 38 cases with monocular convergent strabismus of accommodative type, 9 obtained perfect binocular vision without glasses, 5 obtained perfect binocular vision with glasses, and 5 had good cosmetic appearance but with deficient binocular vision and fusion.

Of the 74 cases of monocular convergent strabismus, of what the author calls the tonic type, 29 completed the treatment, consisting of orthoptics and/or surgery. One obtained perfect binocular vision with exercises and without operation, 6 obtained perfect binocular vision by a combination of orthoptics and surgery, 4 obtained good binocular vision but with intermittent deviation by orthoptic exercises without surgery, 6 obtained a good cosmetic result with orthoptic exercises and surgery but had deficient binocular vision, 7 obtained good fusion on the machines but showed small angles of deviation off the machine following exercises and declined to accept the suggested surgery, in 2 patients a small residual postoperative angle of squint persisted which could not be cured, and 3 showed recurrence of the preoperative angle of squint due to persistent abnormal retinal correspondence.

Of 6 cases of alternating convergent strabismus, 2 completed treatment, 1 obtained perfect binocular vision, the other a good cosmetic appearance without good binocular vision, both after orthoptic exercises and surgery.

Seven of the 13 cases of divergent monocular strabismus completed the treatment of exercises and/or surgery. Four of those, treated only by orthoptic exercises, obtained perfect binocular vision but had occasional deviation when fatigued, 1 obtained by operation good cosmetic result without binocular vision, 1 had a recurrence of the deviation after treatment and operation due to persistent abnormal retinal correspondence, 1 has completed orthoptic exercises preoperatively with good fusion at his angle of deviation and is expecting to be operated on.

Of 8 cases of alternating divergent strabismus, 3 have completed the course of orthoptic exercises without surgical intervention, and all 3 have obtained perfect binocular vision.

Of 4 cases of vertical strabismus, no modification whatever of the angle of squint was obtained by orthoptic treatments alone.

24-2

Fagi, Y.: *Orthoptic treatment of squint,* Harefuah, 39:6-8, 1950. (In Hebrew with English summary.)

The author reports the activities of the orthoptic clinic, established a year ago in Israel, of the Sick Fund of the General Federation of Laborers in Haifa. Early treatment is emphasized by the author, and every patient has to be sent to the oculist at the first suspicion of squint.

The author states that 70 per cent of the treatments gave good results. In half of the cases the treatment was a full success; in the other half improvement was satisfactory.

24-3

Lyle, T. K.: *Orthoptics,* M. J. Australia, 2: Nov. 12, 1949.

This paper deals with the beginning of orthoptics in England in 1930 and the advancement and aim of orthoptics today.

24-4

Pavia, J. Lijo and Piantoni, G.: *Estrabismo. Operaciones y reeducacion* (Strabismus. Operations and orthoptic training), Rev. oto-neuro-oftal., 24:87-92 (Sept.-Oct.) 1949.

The authors are very enthusiastic about orthoptic training. Without following surgery by orthoptic training no one can be sure of the operative result, regardless of the procedure used. They use Worth's amblyoscope for their training because it is simple, inexpensive and permits a considerable amount of convergence. The authors believe in early surgery and postoperative orthoptics, preferably within the first 48 hours.

The authors report in detail on 8 cases, all of which had a convergent strabismus varying from 20 to 60 degrees. The patients were 4, 7, 9, 19, 19, 28, 16, and 41 years of age. After surgery these patients obtained single binocular vision with the Worth amblyoscope. The cases were selected on the basis of the good will of the patients in cooperating with the doctors and their ambition to have their strabismus cured.

25-1

Guibor, George: *Surgical treatment of exotropia resulting from anterior internuclear ophthalmoplegia,* Am. J. Ophth., 33:1837, 1950.

Dr. Guibor reviews the various possible surgical methods for the correction of exotropia, citing the opinions of a number of investigators.

The exotropia that follows anterior internuclear ophthalmoplegia, according to Guibor, is characterized by (1) exotropia at both near and far, (2) insufficiency of one or both medial rectus muscles in lateroversion, and (3) normal convergence. The case histories and illustrations are strongly suggestive of what has been called intermittent exotropia by other investigators.

The author finds his greatest number of cures in those who had a bilateral recession of the lateral rectus muscles and bilateral resection of the medial rectus muscles all at the same operation. He believes the method is satisfactory and has been bothered not at all with overcorrections.

25-2

Meisenbach, A. E., Jr.: *Paralysis of external rectus muscle in hypertelorism,* Am. J. Ophth., 33:83-87 (Jan.) 1950.

The condition of ocular hypertelorism, an undue separation of the orbits, and its effect on the ocular movements is described. The majority of these patients suffer from visual field loss, poor ocular movements, strabismus, and defective binocular vision.

A case report of a five year old boy who had bilateral paralysis of the lateral recti with an alternating esotropia coupled with an overactive left inferior oblique is presented. Following two operations, in which transplantations were done, the patient was orthophoric for distance and near.

It has been found that orthoptic training following surgery is very beneficial in such cases, and they show almost daily improvement.

26-1

Brown, E. V. L.: *Comparison of refraction of strabismic eyes with that of nonstrabismic eyes from birth to the twenty-fifth year,* Arch. Ophth., 44: 357-361 (Sept.) 1950.

The author has made a table and graph for each year up to the twenty-fifth, comparing the refractive error of strabismic eyes with that of nonstrabismic eyes under atropine cycloplegia and the net hyperopia or myopia present.

1. The amount of hyperopia present in the strabismic eye averages over + 3.00 D in excess of the nonstrabismic eye up to 25 years of age.

2. The strabismic eye loses much of the early hyperopia and even becomes a little myopic before the age of 25.

3. The decrease in hyperopia takes place after the eleventh year in the strabismic eye, whereas in the nonstrabismic eye it occurs right after the seventh year.

4. The rate of decrease of hyperopia is much slower in the strabismic eye, 10 per cent decrease a year, while in the nonstrabismic eye the decrease is 20 per cent per year.

5. The average eye becomes more hyperopic up to the age of 6 or 7, strabismic or nonstrabismic.

26-2

Pascal, J. I.: *Physiological study of refractive errors,* Eye, Ear, Nose and Throat Monthly, 29:550; 622, 1950.

The organism as a whole must cope with the distress caused by refractive errors. What and how one sees depends on the general physical and mental condition of the individual.

The author discusses emmetropia, visual

acuity and accommodation on a physiologic basis. With such definitions in mind he explains reason for variations in measurements taken under dissimilar conditions. On evaluating the results of examinations it is important to consider the power of the mental eye behind the physical eye.

Physiologic accommodation concerns the neuromuscular effort involved in the act of accommodation. The unit used is the myodiopter, one such unit standing for the neuromuscular effort required to bring about a change of one physical diopter.

The author explains the bearing of this concept on refractive corrections.

28-1

Burian, Hermann M.: *The principles of surgery on the extraocular muscles, Part I,* Am. J. Ophth., 33:380-387 (March) 1950.

The author points out that operations on the extraocular muscles are usually relatively simple provided certain fundamental principles are considered. These principles are, in general, the etiologic factors responsible for phorias and tropias, namely innervational factors, fusional factors, and noninnervational factors.

A discussion follows, considering the various surgical procedures possible for correction of concomitant horizontal strabismus.

28-2

Burian, Hermann M.: *The principles of surgery on the extraocular muscles, Part II,* Am. J. Ophth., 33:577-582 (April) 1950.

In part II of his paper, Dr. Burian discusses his choice of operation in concomitant strabismus of the vertical muscles, in paralytic strabismus, and in the phorias. Some surgical procedures that are sound in principle are not always practical, and the choice of surgery should be left to the judgment and experience of the surgeon.

Dr. Burian then discusses the application of the general principles to surgery in paralytic strabismus and in heterophoria.

28-3

Dunnington, John H. and Regan, Ellen F.: *Factors influencing the post-operative results in concomitant convergent strabismus,* Arch. Ophth., 44: 813-822 (Dec.) 1950.

In this paper a study is made of 79 cases of surgically treated concomitant convergent strabismus with the evaluation not only of their results but of the following preoperative factors considered:

1. Refractive error. The higher the hypermetropia the more conservative should be the surgical treatment; more than 4 D seems to increase the tendency to a secondary divergence postoperatively.

2. Visual acuity. Secure best possible vision before surgery in order to retain good operative results. The foremost factor influencing poor results in the above cases was the presence of low visual acuity in the squinting eye.

3. Deviations. Prismatic measurements are more accurate than any, always being made in different directions of gaze at different distances. The reader is reminded that many factors in addition to the degree of deviation have to be considered in order to bring about the proper operative procedure.

4. Fixing eye. These authors divide this into three groups: indiscriminate fixation, homonymous fixation (this group generally has some spasm of convergence and responds well to bilateral recession), and heteronymous fixation (this group does not have any overaction of convergence but often has some limitations of outward motility, thus responding better to resection of external rectus muscles).

5. Near point of convergence. This is of great importance because poor convergence or absence of convergence can cause an outward deviation for near when operative result is good for distance.

6. Rotations. This done with each eye fixing makes it easy to note the limitations of motion in any particular direction of gaze, thereby helping the surgeon to decide which muscles are involved.

7. Vertical deviations. The lateral deviations should be corrected surgically first, and only in cases where the vertical exceeds or equals the lateral do these authors feel both should be done in the initial operative procedure.

8. Retinal correspondence. These authors feel the presence of abnormal retinal correspondence is not a contraindication to operation, nor does its persistence after operation greatly influence the ultimate position of the eyes. They believe that the development of normal retinal correspondence and of fusion is aided by proper alignment of the eyes, sometimes being the consequence rather than the cause of a good surgical result.

9. Orthoptics. The value of orthoptic treatment is still undecided. As a postoperative measure it cannot be expected to do more than to stabilize the results. Defective fusion is more troublesome than absence of fusion.

Operative failures are usually attributed to two things: slipping of sutures and excessive adhesions. If the muscle is in the proper position at the close of the operation, there is no need for slipping of sutures. The most frequent factor leading to poor results is postoperative adhesions. Presence of such adhesions can be elicited by passive rotation of the globe with forceps; any resistance is proof of their existence.

Secondary operations may be necessary, due to either overcorrection or undercorrection. In 22 of the 79 cases secondary operations were necessary, and from a study of these the impressions were (1) that overcorrections demand more radical treatment than the original deviations, (2) that undercorrections must be treated cautiously.

28-4

Guibor, George: ***The surgical treatment of exotropia resulting from anterior internuclear ophthalmoplegia,*** Am. J. Ophth., 33:1837-1842 (Oct.) 1950.

The results achieved in 31 patients with exotropia associated with internuclear palsy who received surgery are discussed.

Three types of surgical procedures were used: (1) advancement of the internal rectus muscles without resection and without retroplacement of the external rectus muscles, (2) advancement of one internal rectus with retroplacement of the external rectus, and (3) bilateral resection of the internal rectus muscles with bilateral retroplacement of the external rectus muscle.

Of the three types of surgery, the latter was much more effective.

28-5

Loutfallah, M.: ***Clinical physiology and operative indications in surgery of inferior oblique,*** Eye, Ear, Nose and Throat Monthly, 29:543, 1950.

Vertical deviations depend on (1) physiologic position of rest, (2) anatomic attachments, (3) paralysis and its state of recovery, (4) preferred fixation, (5) state of fusion, and (6) abnormal excitations of centers controlling parallel movements. Bielschowsky's classification of vertical deviations ranges from purely comitant through paretic through normal overaction to dissociated types.

Vertical surgery is indicated only in the stable (and comitant) types. Early surgery is advisable to prevent possible torticollis and other faulty habits. Indications for the type of surgery to be chosen by the physician are given. Thirty-one cases are tabulated showing the postoperative results.

28-6

Ocampo, G. D.: ***Why and how early during childhood should squinters be operated on,*** Philippine J. Surg., 5: 118-123 (May-June) 1950.

The author reviews 60 cases of strabismus; the youngest was 5 months old and the oldest 70 years old. Twenty-four cases were divergent strabismus and 36, convergent strabismus. There were only 4 that were of the paralytic type while the rest were concomitant. There were only 5 cases below 6 years of age, and 15 cases were younger than 11 years. Of the 60 cases, 23 patients were operated on; the youngest was 6 and the others between the ages of 18 and 30.

Ninety per cent of the cases were older than 5 years when they consulted for treatment; 80 per cent were over 14 years of age.

The author believes that many put too much stress on the power of glasses to correct strabismus and that there is still the belief among some that squint might be outgrown.

The author states that early surgery is very important. The postponement of surgery until the patient is 14 years of age or more may present psychologic trauma. It requires more operative accuracy to attain good correction in an adult than in a child. If possible, surgery should be done before the child enters school, but there is no unanimity of opinion as to the minimum age There are many factors to consider before surgery is decided, such as the age of onset, the type of squint, the amount of deviation, the accommodational and innervational elements involved, and the effect of glasses on the squint.

In his experience the author has found very few congenital squints, many of them developing after birth. In such cases of strabismus that develop after birth, "since the accommodational factor has its most influence about three years of age, the preoperative treatment should be shorter and surgery done as soon as possible."

In cases of exotropias, the author believes that few exotropias become manifest at an early age. This type of strabismus requires close observation and should be studied "thoroughly and carefully" before surgery is

decided upon. Some authorities do not indicate surgery until 10 or 12 years of age in exotropias.

Alternators can be operated upon at a later time than monocular squinters.

Before surgery is done, measurements should be taken several times, noting the fixing eye and noninterference from cycloplegic. The Hirschberg test is used in younger patients, and in adults, the perimeter and prisms. The author states that preoperative orthoptics in addition to glasses and occlusion may prove to be effective in overcoming an angle of 15 or 20 degrees without surgery. If the angle is over 20 degrees, orthoptics is given postoperatively.

"The factors other than developmental and surgical inaccuracy tending to prevent the eyes from remaining straight after operation are suppression, amblyopia, abnormal retinal correspondence, and deficient fusion." All these are better corrected in young children than in adolescents.

Abnormal retinal correspondence should not prevent interference of surgery in a child or adult unless there is eccentric fixation and severe amblyopia, since one has more chances of restoring normal retinal correspondence when the visual axes are close to parallelism.

Every nonsurgical treatment one has on hand should be made available to the patient before considering surgery. "A period of about six months of nonoperative treatment—occlusion, glasses, and orthoptics—is a sufficiently long trial period before final decision to operate is made."

28-7

Scobee, Richard G.: *Some practical points about the recession operation,* Am. J. Ophth., 33:583-590 (April) 1950.

According to the author, there is much variation in the results of the recession operation because of the variation in technic of performing it. One technic which yields rather large amounts of correction is described in detail. Scobee believes that it is easy to perform and has found it satisfactory in the hands of even relatively inexperienced operators. There is little postoperative reaction, and orthoptics may be initiated soon after operation if this step seems desirable.

29

Foster, C. B.: *Headache as a symptom of visual disability,* Am. J. Ophth., 33:773-776 (May) 1950.

From his clinical practice, Dr. Foster tabulated 434 cases that had been examined because of visual complaints exclusive of pathologic conditions. Of these 434 cases, 163 (37.5 per cent) suffered from headaches alone, or from headaches in conjunction with other symptoms.

Poor near vision and fatigue (asthenopia) were found associated with headaches most frequently. Subnormal vision came next and dizziness was fourth.

The patients were then grouped according to whether the headache was localized anteriorly or posteriorly. Several interesting points were noted about the relation between diagnosis and localization of symptoms.

The reason all patients do not develop headaches was discussed. Comparing two patients, each with the same degree of a given visual disability, one patient being calm and relaxed, the other under great emotional stress, the first will usually exhibit no headache, whereas the second will likely show severe pain.

30

Berens, Conrad and Fonda, Gerald: *Accommodation and near test card,* Am. J. Ophth., 33:1788-1791 (Nov.) 1950.

A new accommodation card to determine visual acuity and range of accommodation at near is presented and described.

34-1

Sloane, A. E. and Gallagher, J. R.: *Changes in vision during adolescence,* Am. J. Ophth., 33:1538, 1950.

Data from annual examinations of 228 adolescents over a period of three years are reported. A modification of the Massachusetts Vision Tests was used. No change in binocular unaided visual acuity was found in 74.5 per cent, while 7.5 per cent showed a decrease of more than one line on a Snellen-type chart.

There appeared to be no significant change in heterophoria noted in the adolescents during the three-year period.

The authors conclude that although the frequency and extent of changes in visual acuity

in adolescents are not great, nevertheless they are sufficient to suggest the desirability of an annual visual screening examination.

34-2

Sloane, A. E. and Gallagher, J. R.: *The vision of adolescent boys,* Am. J. Ophth., 33:1746, 1950.

The authors present data obtained with a modification of the Massachusetts Vision Test used in examining 1,129 adolescent males between the ages of 13 and 19 years. Seventy-two per cent of the group had 20/20 binocular acuity.

Two per cent of 779 boys who did not wear glasses could not pass the examination for hypermetropia, that is, they had too much hypermetropia.

Better than 98 per cent had less than 1 diopter of hyperphoria. Ninety-five and six-tenths per cent had between 4 prism diopters exophoria and 6 prism diopters esophoria at far. At near, 98 per cent had between 6 prism diopters esophoria and 8 prism diopters exophoria.

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Orthoptists are undoubtedly interested in a listing of the members of the American Orthoptic Council and the various committees in the Council. The American Orthoptic Council is composed of three representatives from the American Ophthalmological Society, the Section of Ophthalmology of the American Medical Association, the American Academy of Ophthalmology and Otolaryngology, and the American College of Surgeons. Four associate members are elected to represent the American Association of Orthoptic Technicians. The names and addresses are as follows:

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